SCIENTIFIC ADVICE IN GOVERNMENT DECISION-MAKING

THE CANADIAN EXPERIENCE

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Abstract

Widespread controversies over fish stocks, tainted blood and rBST highlight the interplay of science and political culture. They underscore the fact that policy decisions often are taken with uncertain scientific knowledge and either implicit or explicit consideration of social, economic, environmental, legal and ethical risks and benefits. Policy options are identified and broader implications are considered in a risk assessment/management process that builds on and goes beyond science.

The use of credible science is a well established and important part of decision-making within government at both federal and provincial levels. Understandably, how science is used and integrated into decision-making and policy takes different forms at different levels of government and in response to different needs. Program Review (1995), budget constraints, and recent and ongoing controversies in public policy have triggered widespread debates and active examination of policies and procedures for the use of science in decision-making.

Other countries are having similar debates. They are exploring options to ensure the credibility and refine the use of science in government decision-making. Underlying these debates are three fundamental concerns - public confidence in the science decision-making process; the tension between the opportunities opened by science and their acceptability in the face of prevailing social values; and the role of science as a public good.

Addressing these concerns requires a series of initiatives to redefine the environment in which science is used for policy and to improve the mechanisms, processes and risk communication involved in science-based decision-making. A shift towards a more open debate on those broad issues of public concern which have a strong science component and large social and economic implications would provide a powerful underpinning and be fully in line with international experiences in addressing such concerns.

Strengthening the Process

The development and implementation of a set of science advice guidelines for use in policy making is important to support and strengthen existing practices. This will require active promotion and communication of science guidelines within the government system, as well as the explicit identification of individuals responsible for their implementation within departments and agencies. An adequate system of monitoring the implementation will be necessary.

There is a high degree of support within the Canadian federal system for an approach similar to the principles and guidelines articulated by Sir Robert May for use in the UK. They focus on the early identification of issues for which scientific advice will be needed, how sound science is integrated into the decision-making process and the importance of openness in the interpretation of scientific evidence. Effective processes in each of these three areas are particularly important where government decisions

relate to policies drawing on science with a significant degree of uncertainty or where conflicting opinions are strongly held.

Guidelines benefit from being applied at the highest level of decision-making. One way to do this in Canada would be to require a check off on any Memorandum to Cabinet (MC) with some science component to acknowledge the use of the science guidelines in the formulation of that advice.

Clarifying the Policy Context for Science Advice in Government

There is concern with the capacity to integrate science advice with government decision-making. Two issues arise. First, the purpose of in-house science, as either source or recipient of the science for science advice, is undermined in the absence of a well-defined client (and hence a well-defined demand). Secondly, there is a major cultural clash between science and policy within many departments. Among the means of addressing the first issue would be to extend the existing requirements for Annual S&T Outlooks and Performance Reports to include a stronger articulation of the linkage between a department's research strategy and its policy responsibilities. These policy responsibilities often extend well beyond any one department; those cross-cutting issues could be a particular focus of attention. Among the means of addressing the second issue are the provision of in-house training to staff on the complementary role of science and policy within government; and means of ensuring recognition of individual contributions to bridging science and policy in the career reward system.

However, better and more explicit use of science in government decision-making and improved understanding of the role of science in government does not resolve the broad contextual issues within which the science decision-making system operates.

The risk assessment/management process is an important means of integrating science into policy. Risk analyses are now well established in most agencies of government. However, too often, risk assessment/management is viewed as a simple extension of the science advice process. Risk assessment/management goes well beyond science. It is important not to define the "hazard" too narrowly, ignoring citizens' concerns with acceptable risk. Departments and agencies could better articulate their risk assessment/management processes, with guidelines to ensure that the full range of necessary expertise is utilized, including scientists (natural, physical and social), ethicists, economists and others. An effective communications strategy would be an integral part of the risk assessment/management process and be targeted at improving public understanding of risk and uncertainty, and providing evidence that there has been proper consideration of all factors.

Managing Uncertainty and Perception

Most government decision-making which includes science advice is routine and hence "invisible" and

non-controversial. The approaches explored in this report will strengthen this broad area of decision-making and will bolster public confidence. Regardless of the presence of guidelines, however, some issues will unexpectedly move to headline status and beyond routine status. Good process will help governments manage such controversies.

Standard procedures are inadequate to address a growing array of high profile, inter-disciplinary, cross-departmental issues that face Canada, and indeed other nations. Typically, these issues involve a high degree of scientific uncertainty, impinge on emerging, contentious areas of science and have the potential to generate a clash between science, social values and economic interests. Climate change, biotechnology, development of large scale mega projects are examples.

As many countries have found, pursuit of the government goals, and indeed management of larger horizontal public issues cannot be addressed without a stronger commitment and leadership that transcends traditional ministerial divides in matters relating to science for government decision-making.

International experience reveals the importance of one individual being assigned the role of honest broker in matters of S&T with responsibilities and accountability for leadership and coordination of cross-cutting issues that involve science within government. Experience is that such a responsibility is best exercised without assuming operational activities or budgetary control for science. The focus is on support to Ministers and line managers in delivering on their individual S&T responsibilities and accountabilities. The position would also reinforce and be responsive to the need to evaluate scientific evidence within the framework of the standards of evidence used within the judicial system.

Managing the science component of large complex science issues is not simply a matter of good communications after an in-house decision has been made. It requires a cultural shift in favour of more open decision-making, one in which the public is firmly engaged.

Both federal and provincial governments use a range of mechanisms to obtain external, and some public, input on controversial issues. Different mechanisms suit different political cultures and individual issues. The overall need is to i) stimulate a broader public involvement, ii) draw on a larger knowledge base, whether in our universities, boardrooms, or communities, or from off-shore and iii) contribute to more timely and better decision-making. While there is no one "best practice", there does appear to be a gap in the existing national science infrastructure for broader public engagement.

Canada needs some fora for securing greater public understanding and support, e.g. a means to raise issues in the public domain prior to decision-making to engender public confidence in the decision-making process itself. Lessons could be drawn from the experiences of countries such as Norway (the Nordic Ethics Committees) that have established structures to promote informed debate and trigger timely science and risk assessment processes. Additionally, providing a formal channel to receive and assess public input and concern regarding science-based decision-making in government could be

considered. Such moves would signal a cultural shift in addressing changing social values and emerging ethical concerns outside government.

1 Background

1.1 Introduction

There is an expanding range of sensitive public policy issues on which governments and civil society expect science to provide insight and illumination of policy options. Front page news profiles the ongoing public debates on the sustainabilty of Canada's natural resource base (e.g. the ground fish stocks in the East and old growth forests in the West), rapidly increasing concern with public health and safety (e.g. the security of the blood system, registration of new drugs, the safety of genetically engineered food products), and the larger question of the sustainability of the biosphere. But the insights of science go well beyond this - to virtually every aspect of the daily business of government.

Good science advice is a necessary, but not sufficient, condition of good policy making. The use of science can support management and decision-making, provide new information and understanding, and help evaluate the probable impact of decisions. It can also help define alternatives and better balance competing interests. This use of science for policy can span a wide range of environmental, economic, social or other concerns and can also involve most functions of government. When well founded and effectively communicated, its use can maintain and restore public and political confidence. Heightened public concerns about the integrity of the science or the integration of science into the government's decision-making process can seriously compromise public confidence.

1.2 Genesis of the Study

The Council of Science and Technology Advisors (CSTA) has the mandate to provide an external perspective on internal federal government science and technology issues and identify opportunities for interdepartmental cooperation. Working in close consultation with the ADM Committee on S&T, CSTA reports to the Cabinet Committee on Economic Union (CCEU).

CSTA has been asked to develop a set of guidelines for the use of scientific advice in government decision-making. Inherent in this charge are the questions highlighted in a recent CSTA paper:

- Increasingly the media in Canada has raised concerns regarding the government's ability and credibility in addressing science-based issues, particularly as they relate to government regulations and policy. Does the public have confidence that the government has an effective process to identify and use "good science" and scientific advice in reaching policy and regulatory decisions? If not, where are the particular areas of concern?

- If public confidence is eroding, what is required to re-capture it? In particular, what mechanisms or processes are required to ensure public confidence that the government is effectively using scientific advice in making critical decisions? How does government ensure

that accountabilities exist to sustain public trust?

This study was commissioned by CSTA to help characterize the current policies and practices for integrating science with policy and to provide some insights on principles and procedures, including those relating to implementation and adherence, which appear to be successful in ensuring that government decisions take account of scientific advice. Appendix A reproduces the Terms of Reference for the study.

1.3. Definitions and Understandings

In this report the term "science" in scientific advice is interpreted broadly, framed by the Statistics Canada conventions, to embrace research and development (R&D) and related scientific activities (RSA):

> "Research and experimental development (R&D) comprise creative work, undertaken on a systematic basis in order to increase our stock of knowledge, including knowledge of man, culture and society, and the use of the stock of knowledge to devise new applications." (Frascati Manual; 1993, page 29)
>
> Related scientific activities (RSA) include data collection, surveys, routine testing and science assessments.

This definition captures a spectrum of activities that range from creative activities designed to resolve scientific and technological uncertainty through data gathering and interpretation to systematic examinations and characterizations of the state of knowledge, including what is not known and the uncertainties associated with what is known. It includes the social and human sciences.

Decision-making on science related issues entails a number of other concepts, including risk assessment and management. Definitions of these and other concepts used in this report are no more neat and tidy than the above definition of R&D and there is a wide range of interpretation in the literature. Appendix B provides the working descriptions of the various terms used in this study.

The second component of the mandate for the study refers to the use of science in "government decision-making". This report, therefore, focuses on the integration of science into government decisions, whether policy, regulation or operational, but does not refer to "policy for science" except where there is a direct relevance to the effective use of science in decision-making .

1.4 The Study Methodology

The study methodology was designed to develop a general picture of the use of scientific advice in

Canadian government decision-making (primarily federal, but with some provincial focus) and to provide insights for improving the framework for science based decision-making at the federal level. The study topic is wide ranging and the focus of much debate within the federal government system at present. As such, the study is a "snapshot in time" during a period of fairly rapid evolution in the interface of science and decision-making.

A four-step approach was used:

i Review of the literature and development of a set of discussion issues that draw down on Canadian and international experience and best practice
ii An intensive set of interviews with individuals within government (both federal and provincial and at various levels of responsibility) and key external stakeholders designed to provide information and insights on current policies, practice and issues
iii Analysis of available documentation (guidelines, case studies and reviews)
iv Synthesis of the key issues and preparation of the report exploring means of improving the integration of scientific advice in government decision-making

Consistent with the background CSTA documents, the study examined current policies, procedures and practices in Canadian government departments and agencies in the context of the science guidelines framework that has been developed and used in the UK.

The investigative phase of this report involved an extensive set of interviews with officials involved in a number of federal agencies and departments - Fisheries and Oceans, Health Canada, Environment Canada, Natural Resources Canada, Agriculture Canada, The Canadian Food Inspection Agency, Industry Canada, and Privy Council Office. Additionally a number of external stakeholders with a direct interest in the mandate, operation or oversight of these departments were interviewed, including representatives of the Royal Society of Canada.

Five provinces were also the focus of a necessarily more cursory review: Alberta, Ontario, Quebec, Nova Scotia, New Brunswick.

The names of those interviewed and the set of issue questions utilized are reproduced in Appendices C and D respectively.

2 The Environment for the Use of Science in Government Decision-Making

"Science and technology will require ethical and governmental decisions that involve scientific sophistication and complexity that many politicians and individuals will not understand and for which governing systems are unprepared. Governments will face

severe questions on who benefits from (and who pays for) very expensive high technology medicine, how and in what ways the state will regulate genetic engineering, and how to allocate funds among competing claims for scientific research. They will face challenges from the intervention of scientists and other knowledge elites in issues of wide public concern."

Uncertainty is the Price of Freedom - paper prepared for discussion at the 1996 OECD Ministerial Symposium on the Future of Public Services"

2.1 Why Governments Need Science

While this study is designed to focus on "how" government uses science in decision-making, that discussion must be framed by a reasonable understanding of "for what functions" and "why" government needs science. In 1991 the Carnegie Commission on Science, Technology, and Government suggested that in its policy role, government:

- supports S&T as a public good
- controls S&T for the public good (health and safety, environment, security)
- uses S&T in decisions to inform decisions on major public issues

This report concerns the last two roles, i.e., ***where governments use science in decision-making,*** including that science performed for government. Adapting a useful taxonomy from a recent paper prepared for the Science ADMs by John de la Mothe, one can identify the following governmental decision-making functions that are informed by science:

- Security
  - Defence, international and civil security
  - Emergency preparedness, especially for natural disasters, e.g. earthquakes, floods (responsiveness, warning, and universality)
  - Adaptation to foreseen threats, e.g. the design of PEI fixed link incorporating provisions for rising sea level forecast to result from climate change
  - Economic security, e.g. in areas such as data encryption where there is both a security issue for Canada (in privacy for example) that will involve government regulatory functions and economic considerations

- International policy and negotiations
  - Establishment and negotiation of standards in order to harmonize Canadian and international regimes to protect Canadians (many non-tariff barriers are heavily technological)

- Provision of a favourable export climate through demonstration of high standards for high risk products and rigorous resource management standards
- Negotiation of international conventions (e.g. biodiversity, Law of the Sea)

- Individual health and safety
  - Evaluation and verification of the safety of new products, including drugs, bio-medical devices, vaccines, blood products
  - Management of a regulatory regime (making regulation, compliance and enforcement process, monitoring and reporting) that provides public confidence, adequate monitoring and regulatory control of products and activities that could have an adverse effect on human health and safety, e.g. food, drugs, consumer product safety, transportation safety

- Environmental protection
  - Management of a regulatory regime (making regulation, compliance and enforcement process, monitoring and reporting) that provides domestic and international confidence in environmental protection consistent with sustainable development
  - Monitoring and reporting on the Canadian eco-system
  - Meeting negotiated international treaty levels (e.g. greenhouse gases), and provision of the necessary cross-cutting monitoring and reporting to international norms
  - Management of the "commons" (e.g. fish stocks, biodiversity)

- Development of effective policies in all sectors of the government mandate.

Governments use science advice in various ways ***to deliver on these functions*** (Smith 1997):

- *Factual insights* - to help identify and frame problems and to understand a situation
- Knowledge to allow *assessment and evaluation* of the likely consequences of a policy
- *Arguments, association and contextual knowledge* to help policy makers reflect on their situation and to improve and sharpen their judgements
- *Procedural knowledge* to help design and implement procedures for conflict resolution and rational decision-making.

2.2 Government Science-Based Decision-Making

While many of these functions and the needs of government for knowledge input are of long-standing, several forces have raised the stakes in government decision-making and hence made more urgent the need to reassess what and how scientific advice is integrated in decision-making. These forces include: i) new science and new technologies (especially biological) that are seen to impinge directly on individual health and safety, environmental sustainability or personal privacy and security; ii) the

interdependence of nations in governmental decision-making that frequently involves high-level scientific understanding, for example the Kyoto agreement on reductions in greenhouse emissions and non-tariff trade issues under the World Trade Organization and the North American Free Trade Agreement; iii) a greater public sensitivity to perceived risks, fueled by a few major public policy failures that have a strong science component, e.g. Hepatitis C and cod stocks.

Internationally governments have found that traditional procedures are inadequate to address the growing array of high profile, inter-disciplinary, cross departmental issues. Governments need access to cogent, pertinent, and timely science advice targeted at their specific needs. But there are many ***complexities in integrating science into policy***. Among these are:

- the fact that research is not neat and tidy. Research is not value neutral; factual evidence must be clearly distinguished from individual values and assessments. Research and science do not necessarily produce pertinent evidence on a time frame consistent with political decision-making; Science and scientists stress areas of uncertainty and inadequacy of information; governments face decision-making in the context of uncertainty;

- the nature of government decision-making - e.g. that policy issues requiring science input are frequently complex, with wide social, cultural, political or economic implications and hence require an equivalent array of inputs to the decision;

- the need to bridge the differing value systems and norms for communication of science and of policy. Science relies on broad dissemination and academic challenge through open publication and peer review. Policy, on the other hand, tends to be developed and determined from internal sources in the context of the Westminster model of government.

The use of science extends to all levels of government decision-making, but the area where energies and international "rethinking" is particularly focused is on the level of decision-making where the time horizons are long, the decisions required are complex, and involve many different types of expertise, where the risks are high, uncertainty great and where public (and political) concern is probable.

As examined in the companion study on international experiences, there is international rethinking of the structures and processes of government decision-making, that in turn reflects the evolution of thought about participatory democracy and citizen engagement. Underpinning all the debates is a common theme, that of a cultural shift in favour of more openness in the use of science in decision-making. Increased openness is designed to help deal with three common concerns: risk, uncertainty and ethics.

There has also been a significant shift in what is an acceptable basis for government decision-making dealing with a potentially serious risk. Ministers and officials are being called to account for the use, and disregard, of science in their decision-making. The "***precautionary approach***" (see Appendix B) was developed initially in the field of environmental protection, but its applicability to public health and safety

was a key issue in the Krever inquiry, and effectively crystallized in the question to witnesses "when you first suspected that something was wrong, what did you do about it?" More formally, the Rio Declaration of 1992 adopted Principle 15:

> *"In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."*

There is a growing consensus that the precautionary principle, judiciously applied, and followed up with appropriate action to address areas of uncertainty, should stand up to legal scrutiny. The issue then becomes what are the implications of the precautionary principle and what is "due process" in its application. This raises the issue of "how" science advice is integrated with government decision-making and what are the legal expectations of governments in investing in reducing scientific uncertainties once the initial "precautionary" decision has been made.

Internationally there are efforts to transform regulatory regimes from a focus on up-front analysis of product data prior to approval (sometimes termed the science-based approach) to a new ***risk-analysis based paradigm*** that focusses on the potential for risks and benefits, and the adequacy of post-market surveillance, reporting and communication systems (in all of which science is integral, but not supreme). In this new regulatory regime "science occupies a broader spectrum of shared advisory space containing numerous kinds of knowledge, expertise, evidence and values" (Bruce Doern; Therapeutic Products 1998).

At the same time as these changes are occurring in the policy environment in which government functions, profound changes are underway in ***how governments are doing business***. The reforms reflect concern about economic performance, the evolving demands of citizens and a decline of confidence in government (OECD 1996). Discussions at a 1996 OECD symposium on the Future of Public Services highlighted a number of common themes in both problems and approaches to solutions among OECD governments.

In one session of that symposium - dealing with provision of public services in an environment of strong media influence, single-issue groups and rapid increases in the amount of information available and the speed with which it is transmitted - four "directions" of change were highlighted:

i more active communications with the public;
ii more effective and balanced dealings with pressure groups;
iii strengthening of ethical frameworks for public officials, and
iv broad, open and fair discussions of policy issues.

These "directions" are simply another way of stating the shift to openness and inclusiveness in how governments deal with science in decision-making.

Along with diverse approaches to achieving more openness is the concept of "due process". While it is a mistake to imagine that policies or practices can be simply lifted from one country to another, there are a number of insights from international work that provide a useful framework for this report, in particular recent work in the United Kingdom and New Zealand.

The United Kingdom has recognized and reinforced the need for an effective process of oversight that promotes compliance and continuous improvement (see companion study). The science guidelines generated in the U.K. represent a strong foundation for development of Canadian guidelines and serve, therefore, as a framework for this report.

New Zealand has taken two additional steps that recognize the challenge of moving from policy to implementation:

- Developed explicit operational tools to assist government managers in the implementation process of approved policies.
- Examined the legal issues surrounding the offering of expert advice, especially as it pertains to the scientists, professionals and consultants who offer advice and make delegated decisions (internal and external to government).

3 Mapping the Dynamics of Decision-Making in Federal Science-Based Departments and Agencies (SBDAs)

3.1 The Federal Context

The structure within which science advice is developed and integrated into policy in Canada has undergone significant changes in the last decade. Rather than providing an extensive review of the changes in the federal system, two critical events between 1994 and 1996 are highlighted:

- *Program Review* - a government wide initiative aimed at reducing expenditures and rationalizing activities. This has induced major changes in in-house science capacity.

- The development of a *Federal Strategy for S&T* released in 1996 - "Science and Technology for the New Century" articulated a common framework of operating principles and more importantly, new institutions and mechanisms for governance. It also enshrined the principle of Ministerial authority and accountability for S&T related to their departmental mandates. The Minister of Industry, supported by the Secretary of State (Science, Research and Technology) has responsibility for leading the coordination of S&T policy and strategies across the federal government.

Until recently, much of the discussion and action following from these two events related more to "policy for science" than to "science for policy". It is only now, with structural change being consolidated and rising public controversy concerning a number of key public health, safety and resource issues, that significant policy attention is being refocussed on "science for policy"- or the role of science in informing government decision-making in what is a radically changed context from that prior to 1994.

No department or agency is isolated from the need to access and present balanced science information in order to reduce uncertainty, identify gaps in knowledge and analyze alternative courses of action. All departments face an increasing need to access good science (information and/or knowledge).

This report focusses attention on a subset of departments - those with the most dominant need for good linkages between science and policy. Many others, e.g. the Communications Research Centre within Industry Canada and the National Research Council, are considered to be more oriented towards the private sector as the client for their science and are not the prime focus of this report. CSTA should, however, ensure that their interests are adequately served by new guidelines.

One important dimension in Canada is the division of constitutional powers between federal and provincial governments. The federal dimension is highlighted in the linkage of the activities of Natural Resources Canada and Agriculture and Agri-Food Canada with provincial governments as clients for science advice. An additional dimension is the management of federal-provincial coordination in the follow-up to Kyoto.

3.2 Characterizing Current Principles and Practices

This report reveals the enormous amount of activity currently underway to improve the policies and practices for integrating science with government decision-making. In order to maintain a clear focus on the key issues for consideration by CSTA, while responding to the Terms of Reference, this report adopts the following approach:

- It is organized on the basis of issues, not initiatives or departments
- A number of specific initiatives are outlined or referenced in the detailed departmental profiles (Appendix I)
- Interdepartmental initiatives and initiatives that involve external players are discussed in the core of the report

In his March 1997 policy statement on "The Use of Scientific Advice in Policy Making" Sir Robert

May, Chief Scientific Advisor to the Government and Head of the Office of Science and Technology in the UK, lays out a set of key principles and guidelines for the use and presentation of scientific advice in policy (Appendix E). The core elements of the U.K. policy are:

i *departments should ensure that their procedures allow the early identification of issues for which scientific advice or research will be needed;*

ii *policy making should draw on the best available sources (including overseas), and should also take into account the views of experts in other (not necessarily scientific) disciplines; and*

iii *there should be a presumption towards openness in explaining the scientific advice and its interpretation.*

Robert May; U.K. 1997

These principles form an analytical and organizational framework for this report. They are generally appropriate to the Canadian context, and have been found effective when implemented They have a high degree of support from Canadian officials. Suitably translated into a Canadian context they offer a reasonable means of achieving the overall goals of improved political confidence in the input to decisions and public confidence in the decision-making process. What they do not do is

i provide adequately for two key dimensions of the Canadian context
- the need to incorporate provinces as providers, users and partners in science-based decision-making
- the importance of S&T in foreign policy

ii speak to the means of implementation and accountability for that implementation

The first requires careful crafting of Canadian guidelines; the second is a larger challenge for Canada.

The purpose of the guidelines in the U.K. is to provide a consistency across departments for managing the science input to decision making, thereby improving the overall operation of departments and better achieving government objectives. The guidelines are also seen as a key means of improving public confidence. At one level, these guidelines are quite non-controversial, to some extent a codification of common sense. They do not diverge greatly from what most officials and departments actually do; indeed they appear to have broad support in the UK and in Canada. What they do is provide a useful basis for the assessment of the current state and operation of the science-to-policy process in Canada. For that reason, this report presents its analysis of the current state of the Canadian system of science advice under the same framework.

3.3 Identifying Issues

"Departments should ensure that their procedures allow the early identification of issues for which scientific advice or research will be needed." U.K. Guidelines

In assessing implementation of this principle this report examines four elements:

i procedures to anticipate issues that will need scientific advice
ii pluralism in sources of insight
iii capacity for fast response once issue identified
iv mechanisms for identification of horizontal or cross-departmental issues

3.3.1 Emerging Issues

The U.K. guidelines stress the need for procedures to anticipate and identify as early as possible those issues for which scientific advice or research will be needed, particularly those which are potentially sensitive.

The majority of departments and sectors identified their "***anticipatory capacity***" as less than adequate. Industry Canada described the capacity of the overall system as "very limited". The imperatives of maintaining routine operations for compliance with regulations, and priorities for private sector clients and cost recovery appears to have taken prominence following Program Review.

All departments believe that "foresight" is an important component of their responsibilities, and some have launched specific initiatives for long-range planning. NRCan has an embryonic "foresight" capacity within its policy shop. One sector within NRCan (Energy) woks with a policy focus of 2030; another (Forestry) is moving from a 5 year horizon to a 10-15 year horizon in its planning. Health Canada has recently put in place an internal mechanism that flags, on a routine basis, those issues that have the potential to become particularly sensitive and that may require additional public consultation or science input.

3.3.2 Pluralism in Sources of Insight

The U.K. guidelines stress that information should be drawn from a variety of sources and that no single approach is likely to be adequate.

Science insight is heavily dependent on in-house research and science capacity, especially as a window on domestic and international developments. A few other mechanisms are used to supplement the in-house anticipatory capacity, most notably the External Advisory Boards (EABs) and advisory committees. Some officials see the EABs as playing an important role in identifying issues. However, there is considerable diversity in departmental expectations of, and analytical support for, these bodies. While it is too early in the existence of EABs to assess whether these mechanisms for "identifying issues" are effective, CSTA should consider reviewing their mandates, constitution and structure as to how best to reinforce their contribution to "foresight". There are a number of other liaison bodies used that may also serve as an early warning system, including federal-provincial consultative committees and multi-stakeholder committees (e.g. in the Mining and Minerals Sector of NRCan).

Other less formal or ad hoc mechanisms for identifying issues are used according to the mandate and obvious stakeholders. These include monitoring the "hot" environmental issues (e.g. picking up on the Greenpeace interest in dioxins in fish) and broad public consultations including such stakeholders as the First Nations (e.g. the National Forest Strategy).

3.3.3 Response Capacity

The capacity for ***response to rapidly evolving issues*** is patchy at best. There is widespread concern with the mismatch of mandated responsibilities to support longer-term government policy needs with the lack of capacity to respond rapidly to fast emerging issues. There appears not to have been the same pressure to serve the government as client as there has been to provide a responsiveness to the private sector client.

In two departments the case was made that the capacity to respond to existing, not just emerging needs, had been compromised. Health Canada, for example, was identified in interviews with individuals internal and external to government as having to struggle just to manage its routine mandated activities, let alone deal with emerging issues.

Another aspect of responsiveness is expertise. This too is seen as being problematic. Agriculture Canada identified the challenge in having to respond to a June 1999 deadline for a plan to reduce greenhouse gases within the agri-food sector without the necessary in-house science or research capacity. Departments and agencies are becoming more familiar with contracting expertise for meeting such needs. However, they are often limited by the scope, interests and capacity of the external science community, as well as their internal expertise to be an intelligent procurer of science.

3.3.4 Horizontal Issues

The cross-cutting or horizontal S&T policy structures within the federal government include the Advisory Committee on S&T (ACST), the Council of S&T Advisors (CSTA), the Science ADMs Committee and the 5 Natural Resource Department group (5 NRs). With minor exceptions, all appear to be more focused on policy for science or the management of science in government, rather than in concerted exploration of long-range strategic issues.

With the exception of the window on Europe, there was no reference to the Department of Foreign Affairs and International Trade (DFAIT) playing an active role in science foresight. This would appear to be a lost opportunity.

Throughout the interviews, reference was made to the lack of a ***formal "foresight" mechanism*** along the lines of that in the UK, Australia or New Zealand. Many see this type of initiative as having the particular benefit of strengthening relationships among government, industry and academia and hence

the likelihood of sharing early insights. This appears to be a gap in the Canadian S&T infrastructure.

Overall, the capacity to anticipate emerging issues is recognized by officials as crucial, but remains under-nourished and inadequate. There is still a tendency to look primarily internally for insights. There are an increasing number of mechanisms for horizontal coordination and concerted action, but some major players are absent.

3.4 Building Science into Policy

> *"Policy making should draw on the best available sources (including overseas), and should also take into account the views of experts in other (not necessarily scientific) disciplines"* U.K. Guidelines

Implementing this principle has many dimensions, among them the following:

i Accessing the best science from a wide variety of sources, which in turn entails
   1. independent advice of the highest quality, with potential conflicts of interest clearly documented
   2. the use of international experts
   3. sufficiently wide definition of the problem such that evidence is assessed from a wide range of viewpoints
   4. making public the data on an issue to draw out a wider range of insights

ii The involvement of scientists in helping to frame policy options

iii Attention to effective integration of science in risk assessment

iv Assurance of the quality and relevance of in-house science activities

v Consideration and appropriate representation of diverse views and uncertainty

3.4.1 Sources of Advice

The U.K. guidelines stress the need to draw on a sufficiently wide range of the best expert sources, both within and outside Government. They seek independent advice of the highest calibre and to avoid or document potential conflicts of interest, so that the impartiality of advice is not called into question.

This report refers to both "expert advice" and "independent expert advice". ***Expert advice*** is a normal component of science-based decision-making. It is sought in a variety of ways, including in-house analysis and working groups (some interdepartmental), federal–provincial working groups, external experts working under contract to a department, or expert panels operating under the jurisdiction of a department or agency. In all such cases, the department or agency determines the constitution of the group and the disposition of the final report. ***Independent expert advice*** is obtained from sources outside government and under explicit provisions for freedom of voice. It is likely to be needed in situations where there is a high degree of public sensitivity or skepticism and where fully independent

advice will lend credibility to government's consideration of complex science-based issues.

Examples of sources of expert advice involving external players:

- Climate change issues tables that are developing options for meeting targets established under the Kyoto agreement (multi-stakeholder)
- Community involvement in the development of remediation plans for Hamilton Harbour
- The particulate matter science assessment undertaken in response to the regulatory requirements under CEPA for new National Ambient Air Quality Objectives (federal-provincial and territorial governments; health and environment)
- The Regional Stock Assessment Process of the Department of Fisheries and Oceans that involves fishers and academic scientists as well as in-house scientists
- The expert advisory committees of the Canadian Agricultural Research Council that involve some 800 persons, including government scientists

There is an enormous range of ***approaches used to access, formulate and validate the science*** used in the decision-making process among departments and agencies. Much of the routine decision-making, especially on the regulatory compliance functions, operates on an in-house basis (e.g. the Canadian Food Inspection Agency) using expert advice, but not independent expert advice. There is broader participation in the regulatory development process where stakeholders are increasingly brought into discussions before regulations are formulated. No one pattern emerges for dealing with the broader long-range policy issues, in part because of the rapidity of change in practice in this area. While there is a significant reliance on in-house expertise for the initial science advice, departmental culture and managerial expectations appear to play a key role in determining what approaches are used to supplement that internal capacity.

The extension to experts external to the federal government takes a number of different forms, each of which brings benefits and costs:

- scientists from provincial and territorial governments who normally bring a mix of practical science expertise and policy awareness (vast array of federal-provincial working groups)
- academic scientists, who bring the strength of expert knowledge, international contacts and independence of thought, but normally without familiarity with the policy context
- representational experts, individuals from an organization with a vested interest in the outcome of the policy decision, and a concomitant insider knowledge of the operational realities (e.g. federal expert committee on sulphur in gas)
- independent experts with practical knowledge (e.g. fishers in stock assessment; practicing doctors in pharmaceuticals)

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Management of relationships and conflict of interest can be a challenge. The following extract from a recent report to Environment Canada assessing the outcomes of a multi-stakeholder expert panel highlights the issues that can emerge:

> *"It appears that the benefits of having stakeholder participation in the scientific stages anyway, are largely theoretical and anticipated to be reaped in the future whereas some of the problems associated with this approach are more immediate and apparent...very few tangible benefits had been gained in return for their involvement up front during scientific stages of the assessment, for it was felt that little if any real contributions were made by stakeholder scientists."*
>
> E. Bush; 1998. Report to Environment Canada
> Science Assessment

The message in this example is the need for i) a clear articulation of the reasons for, and nature of, external stakeholder involvement; ii) guidelines for the conduct of the advisory/assessment process consistent with the expected benefits; iii) a means of evaluating costs and benefits.

One recent example of an ***open, inclusive approach*** to the science advice process involves the National Climate Change Process which involves a multi-stakeholder consultative process of expert "issue tables" that are charged with expert and detailed input to the identification and analysis of greenhouse gas reduction opportunities. This includes an analysis of the various options open to Canada to meet its obligations under the Kyoto agreement. Fifteen issue tables have been established, focussing on sectors (e.g. electricity, forestry) or issues (e.g. CO_2 sinks, technology, public education and outreach), each involving 15-25 experts from a wide range of backgrounds, including both policy and technical expertise. The target for completion of the initial sets of options papers for consideration in the National Implementation Strategy is May 31, 1999.

There have been changes in the science assessment process within some departments to include ***non-traditional sources of knowledge and more external participation***. On the East Coast, the Department of Fisheries and Oceans has introduced a two-tier approach to fish stock assessment (the Regional Resource Assessment Process, or RAP) and "oversight" (Fisheries Resources Conservation Council, or FRCC). The RAP involves a broader group in the peer review of the stock assessment data, including fishers and academics. There is also an opportunity for challenge of the interpretations of the science and further input to the data on which stock assessments are based through access to aggregate stock data on the DFO web site. The FRCC itself is more broadly based and has responsibility for quality assurance in the process of stock assessment and recommendations to the Minister on total allowable catches and other conservation measures. However, the new structure for stock assessment and strategic oversight is not uncontroversial. It has institutionalized a regional approach to stock assessment (separation of the Gulf, the Bay of Fundy, Newfoundland). Questions

have been raised within the FRCC as to how regional conflicts in science interpretation, e.g. between Newfoundland and the Gulf, will be reconciled and whether there is sufficient external, particularly international, expert advice. Perceptions from outside Canada are that the system requires further external expert challenge. A comparable system is being established on the West Coast where aboriginal rights and the interests of the sports fisheries add broader societal dimensions to the ultimate decision-making process on catches and conservation measures.

In general, there is a receptivity among senior officials to the concept of acquiring ***independent external advice*** to assist the decision-making process for issues that are, or are likely to be, very controversial. The example of the Royal Society of Canada study on the Health Canada Primate Colony was cited as means of bringing a structured advisory process and credibility of independence to bear on an issue. The appointment of a philosopher as Chair of this committee was seen to have been a factor in its success, enhancing sensitivity to social values and their integration with scientific perspectives. The report made a difference to the disposition of the colony.

Despite some success stories, however, there is not a strong tradition of independent reviews in Canada, unlike the US where over 200 expert reports are produced annually by the academy system (the Canadian equivalent would be 20; we are far from that). Officials noted the lack of a single consortium of existing "societies" (along the lines of the U.S. National Research Council), the lack of an adequate infrastructure in the Royal Society, perceptions that most societies are not representative of Canadian society and values, and the limited number of Canadian experts.

3.4.2 Validating the Quality of Advice

Validation of the quality of the science advice is handled differently according to the ***scale of the issue*** and whether the major science input is external (various types) or internal. The quality assurance of the membership, review process and outputs of Independent External Panels is provided by the organization that manages the review. Demonstrated independence and externally managed quality assurance standards are two of the chief attributes of independent reviews.

Multi-stakeholder panels established by government were seen to be more problematic from the standpoint of i) managing conflicts of interest, especially of industrial participants, and ii) the equity of opportunity for all stakeholders (including government) to have a full voice in the proceedings. The more visible stakeholders can dominate, regardless of content knowledge. There is no *a priori* reason, however, for science assessments from such bodies not to be peer reviewed and formally published as a means of validation. Environment Canada is currently reviewing a recommendation that:

> ***Where appropriate, assessment documents should be published as a collection of peer reviewed papers in an internationally recognized journal, although the trade off may be that "integration" of the document is sacrificed to some extent.***

A few documented procedures exist regarding quality assurance and validation of multi-stakeholder panels, but most are specific to each department and developed on the basis of in-house experience rather than founded in international "best practices".

Validation of the quality of in-house science advice is more difficult to characterize. To a large extent, proxy measures are used. For example, the quality of the scientific personnel within the department may be measured by a combination of publication in peer reviewed articles, external assessment of research units, and the assessment by managers of the science related activities of their groups. Not all departments and agencies currently have a policy of external evaluation of science/research units (i.e. at a program, rather than individual scientist level), but in at least two departments new policies are under review: i) Health Canada is considering approaching MRC for periodic review of its science activities and ii) Environment Canada has developed a draft framework for a formal system of regular expert review of the departmental R&D. The Earth Sciences sector of NRCan already has in place a well established process for a relatively arms length review of the quality and relevance of its science units over a 5-6 year cycle, using the Canadian GeoScience Council (CGC) to manage expert reviews that include international reviewers.

One department (Environment Canada) has commissioned a report on the production of scientific knowledge (in an international context) as measured by bibliometric techniques using a data base that was recently made available through the joint action of Statistics Canada and the University of Montreal.

In summary, while there is an increasing diversity in sources of science advice and validation of the quality of that advice, practices vary widely among departments and the potential benefits of increased external advice (both as sources of science and validation of science) have not been fully realized.

3.4.3 International Dimensions

There are two distinct international dimensions - the use of foreign nationals in the system of science advice and the increasing role of science advice in framing Canada's foreign policy.

Canada is a small country. Contributing at most 4% of the world's science, there are limitations on the range of Canadian expertise that can be brought to bear on any one issue. The close interconnection of scientists within the Canadian community limits insights and perspectives, to say nothing of the potential for conflict of interest. As an example, international observers commenting on the controversy surrounding the use of science for decisions on the management of the East Coast cod stocks have suggested that Canada would be well advised to engage more overseas experts in the Canadian science advice process.

Many expert and independent expert panels involve non-Canadians. The recent expert panels on sulphur in gasoline comprised up to 50% non-Canadians. The Royal Society panel process allows for up to 40% international participation. Availability and cost are often key constraints, but the cost of not casting the expertise net sufficiently widely can exceed the incremental costs of foreign participation.

The second dimension - providing science advice to help position Canada more effectively in the international milieu - is increasingly important. Again, there are a number of venues for this, including such examples as:

- Canadian participation in the establishment of international standards, for example the Codex Alimentarius Committees dealing with food safety (under the auspices of FAO and WHO). Health Canada maintains the Codex Secretariat for Canada; Canada chairs the Codex committee on food labeling (through CFIA)
- Development of the Canadian negotiating position on the next Law of the Sea. Assessment of the scientific implications of various options and interpretation of the scientific/technical dimensions at the negotiating table is critical, and said to have been inadequate in the previous international negotiations.
- Harmonization of regulatory regimes, as is being done through Agriculture and Agri-Food Canada work on identifying approved zones for field trials of agricultural products that would be acceptable to both Canada and the USA. There is further work proceeding on accepting common data inputs in the US and Canada for assessment under separate national regulatory regimes.
- Ensuring that the appropriate tool is used for regulation of health and safety issues in light of current and evolving scientific evidence and concerns with non-tariff trade barriers.

Guidelines for the integration of science into foreign policy require additional consideration by CSTA. The U.K. guidelines are set in the context of a large and influential country within the European Commission and assume a much greater awareness of the interdependence of science and foreign policy than is seen in Canada.

3.4.4 The Mechanics of Integrating Science in Policy

Each department, and often a sector within a department, has its own approach to the role of scientists in the ***development of the policy options*** in a "Memorandum to Cabinet" (MC). At present there is no consistent policy among departments; this may reflect the fact that some departments structurally separate science from operational and policy activities (e.g. Fisheries and Oceans and Agri-Food and Agriculture); others (e.g. NRCan) integrate science and policy in sector units.

Also, there is no explicit reference to the science component of the MC in the instruction manual issued by the Privy Council Office (PCO) in regard to the nature, validation and presentation of the science advice, or a requirement that the source of any science advice be identified. PCO managers appear receptive to the potential inclusion of a science component. The instruction manual for MCs is highly

regarded by senior staff (including science managers) and also widely disseminated among other countries as a "best practices" document.

Science managers at all levels view the ***interaction of scientists with policy makers*** as at the heart of good policy development, and an interface that warrants more attention. There are different ways in which the two groups interact in the development of an MC as typified by the following example.

Sample route to a science-based MC

- The MC process is initiated through identification of a policy need by the policy group within a department. This may be stimulated by a Ministerial request (top down) or through departmental discussions (bottom up).
- Typically, one of two approaches is used:
  1. Broad team assembled from a mix of science, science managers, policy, government process people to develop consensus, or
  2. Policy group that has strong day-to-day working relationships with science personnel develops the MC with informal, but intense interactions with science, reaching down to tap experts wherever found;

  The extent of direct involvement of scientists appears to be a combination of departmental traditions and personality.
- Consensus developed on options and the implications of the policy options built within the department, a process that involves vertical and horizontal consultations.
- Interdepartmental consultations undertaken. Two representative models for this consultation:
  1. Policy group manages the consultation and is the contact point for comments from other departments.
  2. A senior science/technical manager manages the consultation and is the contact point.
- Following revision, including acknowledgment of the diverse reactions of other departments, the MC is advanced to the Minister. The relevant scientific authority may be called on to present contextual information to senior management.
- Potential problems:
  - if the appropriate scientists at the working level are not brought in at the right time by managers, or if there is a lack of policy sensitivity among scientists, the scientific advice may be dropped on the process as simply being too difficult to include.
  - the final "pen" on the MC is a policy person. If the science message is politically difficult and not well advanced by the science people, key messages can be dropped at this stage.
  - There are no formal guidelines on attributing source or validation of science.

Individuals interviewed stressed the importance of improving ***communications*** between scientists and policy makers to make this process more effective. There is a natural tendency of scientists to worry that there will be an overly simplistic interpretation of a complex scientific issue and that a professional scientific opinion will be perceived as a statement of "the opinion of science". As a result, scientists will frequently qualify a scientific opinion and provide a conservative science interpretation that will stress

the need to amass additional data and focus on the uncertainties in knowledge. On the other hand, the policy process deals with the expectation of cogent, timely and pertinent advice, in response to pressures for an early decision and both public and political expectation of action. The challenge for senior managers and policy analysts is to present scientific results in a way that provides input to the policy process without implying more certainty than is realistic. Managing the relationship between science and policy requires constant attention and mutual understanding.

There is a widely accepted need to provide more ***training opportunities*** for in-house staff to promote a better understanding of the complementary role of science and policy within government, the limits on scientific knowledge, and how best to present a scientific argument in a policy context. The Canadian Forestry Service has initiated an innovative in-house workshop program on bridging this science - policy communication gap. This is delivered to the scientists in their home bases (away from headquarters). A focussed set of resource materials has been developed. This example of good practice should be widely shared among departments.

Personnel with a scientific training are relatively infrequent in policy units, despite the fact that many are expected to deal with complex scientific information and inputs. Many officials urge active incentives for scientists with policy capabilities to move into policy positions.

In summary, there are a diversity of approaches designed to manage the science-to-policy process, with scope for improvement in through guidelines and an improved means of implementation. The two dimensions that could be addressed through guidelines are i) the introduction of formal procedures for inclusion of science advice in MCs and ii) the expectation of more consistent use of independent advice for sensitive issues where this would add credibility to the overall process of decision-making

3.5 Presenting Policy/Openness

> *"There should be a presumption towards openness in explaining the scientific advice and its interpretation."* U.K. Guidelines

Key issues in implementing this principle include:

i open dissemination of the scientific evidence and analysis underlying sensitive policy decisions
ii communication of how the analysis has been used in the policy formulation
iii publication of the underlying science
iv release of information to stimulate greater critical discussion of the scientific basis of policy proposals
v professional communication of issues, uncertainties and policy options to public
vi giving scientists a lead role in explaining scientific advice to Ministers and policy officials
vii early communication with key interest groups

The issue of increased openness lies at the heart of the U.K. guidelines. They recommend that "departments should aim to publish all the scientific evidence and analysis underlying policy decisions on the sensitive issues covered by these guidelines and show how the analysis has been taken into account in policy formulation. Scientists should be encouraged to publish their own associated research findings." Even short-term controversy over early releases of information are seen to be preferable to greater controversy resulting from inadequate discussion of conflicting opinions at a formative stage of the policy process.

3.5.1 Publication Policies

All departments and agencies reviewed actively expect and encourage ***scientific publication*** in refereed journals (with the exception of economic analysis that was described as being too close to government policy). Policies regarding publication are frequently embodied in simple sign-off forms that provide a record of internal peer review and authorization from management to publish work done under the auspices of the department. There appear to be few written policies that articulate clearly the actual role of internal peer review, the authority of managers to block publication, or restrictions on scientists addressing government policy (as contrasted with scientific interpretation of the data).

Interviews indicated that some management reviews focus primarily on quality of presentation (copy editing) or validation that management concurs with the public release of intellectual property. Others indicated more concern with the avoidance of statements that can be interpreted as public policy. Within these constraints, there appears to be considerable freedom of communication and interpretation of scientific findings but the lack of codification of the policies may be a potential source of problems.

3.5.2 Public Information

Underlying discussions with officials on the issue of openness is the concern that many scientists have difficulty ***drawing the line between expert science advice and policy***. Public confidence in decision-making requires clear communication of scientific evidence, uncertainty and risk by scientists - both in formal scientific meetings and publications and in interactions with the media. But scientists must also be careful not to over-simplify the decision-making process, implying that science is the unique input, or to appear to provide expert comment on policy.

While again there seem to be few written guidelines, several departments support ***direct interaction of individual scientists with the media*** without prior clearance from management. The only requirements are to speak only about the science and its interpretation, not to comment on political decisions that have been taken and to advise the departmental communication sector following an interview. In some departments a spokesperson is named for a controversial issue. Where guidelines are not written there is room for misinterpretation by both scientists and managers. Professional development and training for scientists in both communications skills and public policy, including

professional ethics, are important.

An increasing amount of material relating to science-based decisions - both the scientific analysis on which a decision is based and the decision process itself - is available on departmental/agency ***web sites.*** The new Canadian Food Inspection Agency has a comprehensive web site that documents the various functions and structure of the agency, the Federal acts under which it is charged with administration, enforcement and compliance, the operational approaches used (e.g. plant-pest risk assessment), presenting copies of decision documents and other related information designed to enhance public understanding of generic and regulatory issues of food safety. The Fisheries and Oceans stock status reports are now released regularly and quickly after peer review (on web site within days of the peer review). The full text of the two external reports to Health Canada that informed the rBST decision were on the web almost coincident with release of the decision by Health Canada. The press release on that decision also identified the role of the science input.

New technology has brought new communication capabilities that are being widely and effectively exploited. At the same time, there are an increasing number of related ***legal and information management issues*** that require careful management attention, including legal liability for external advice, protection of intellectual property, and questions of how far commercial confidentiality of industrial data on which a decision is based should extend.

3.5.3 Communicating Risk and Uncertainty

The ***communication of risk and uncertainty*** is an ongoing challenge. Fisheries and Oceans has introduced explicit recognition of risks and uncertainty through use of graphs of probability of stock increases versus catch level that appears to have made a significant difference in non-specialist understanding of the concept of probabilities. There is a growing body of academic literature on managing risk information that could likely be used more effectively to facilitate the science - policy interface. A Canadian, W. Leiss, has published widely on this issue and a number of international experts contributed their perspectives to a publication on an international conference hosted by Queen's University in 1996 on "Statistics, Science and Public Policy".

In a paper given at the international conference hosted by Queen's (Leiss 1996), Leiss suggests four means of improving risk information:

"i make the communication of probabilistic estimates as accessible as possible, in terms of the ways in which the non-expert public thinks in everyday life situations;
ii make an effort to understand the terms in which the intended audience is framing the risk issues, so that your information addresses their concerns, rather than yours exclusively;
iii tell the whole truth and nothing but the truth when communicating about risks, including uncertainties, and do so voluntarily and in a timely fashion;
iv avoid "there is no risk", or "there is nothing to worry about", statements."

3.5.4 Presenting to Decision Makers

There is no set procedure for involvement of scientists in ***presentation of science advice to senior officials or to the Minister***. Ad hoc decisions are made on the basis of the likely sensitivity of the issue and the extent to which the senior official who would otherwise make the case has a scientific background. For example, the President of The Canadian Food Inspection Agency (who is a lawyer by training) did not hesitate to involve the responsible scientist in presenting to the Minister the scientific case on the Asian Long-Horned Beetle.

3.5.5 Openness Recapitulation

In summary, while there are a large number of healthy changes occurring, the majority deal with openness "after" the decisions. There is increasing outreach to the expert community, but relatively little scope for the involvement of broader society in discussions of sensitive issues while they are still in the policy formation phase.

The lack of a clear coordination point on issues of "science in policy" may well have contributed to an apparent lack of codification of procedures and policies on openness and the emerging issues of information management, ethics and legal standards of evidence. There is enormous opportunity for supporting the ongoing activities of departments and agencies through better application of existing knowledge and through exchange of "good practices".

3.6 Interdepartmental Initiatives

The 1996 *Federal Strategy for S&T* stressed Ministerial accountability for S&T. At the same time it

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The 1996 *Federal Strategy for S&T* stressed Ministerial accountability for S&T. At the same time it

noted that "achieving greater coherence while preserving flexibility, responsiveness and ministerial accountability requires a more rigorous collective review of priorities and greater coordination of activities".

The locus of responsibility for policies and practices related to science for government is not clearly established. However, in addition to CSTA, two groups have adopted a "collective" role in the overall S&T coordination function:

- The ***Science ADMs*** - a group of the science ADMs and their chief advisors from some 14 science-based departments and agencies. This group is co-chaired by the Assistant/Associate Deputy Ministers from Industry Canada and Environment Canada. While it does not yet appear to have a formally endorsed mandate it has taken on overall coordination of generic horizontal issues, e.g. science capacity, technology transfer. This is a large group, said to number up to 40 in full session, and is reported to function best at the level of task-oriented subcommittees.

- The ***5 NR Group*** - a group of five departments (Agriculture and Agri-Food Canada, Environment Canada, Fisheries and Oceans Canada, Health Canada and Natural Resources Canada) that have signed a Memorandum of Understanding on S&T for Sustainable Development. The origins of this group are reported to go back to a pointed question from the Clerk of the Privy Council to the original four founding Natural Resource Departments (the above minus Health Canada) concerning a series of individual Memoranda to Cabinet on related issues that demonstrated a lack of communication among departments. Since that time, a formal MOU has been signed, an annual report published and most importantly, a high degree of respect has been generated for the ability of this group to coordinate S&T policy related to sustainable development and to stimulate collective action on substantive issues.

One significant action to emerge from the 5 NRs group has been the "***Best Practice***" initiative led by Health Canada - an initiative designed to develop a codified set of best practices for the conduct, management and utilization of science.

In preparing this initiative, several regional workshops were held involving scientists, science managers, policy advisors and senior executives to identify key issues relating to the conduct, management and use of science in the federal government, and to develop a set of "values, stakeholder traits and best practices" that could in turn be reviewed by senior officials for adoption across departments. The document is still under development, but the January 15, 1999 version lays out proposals for:

- Fundamental Values - standards that all members of the federal science community should apply in their daily work.
- Traits of Key Stakeholders - expansions of the values as they apply to specific groups within the federal science community.
- Best Practices - specific measures and advice to resolve current issues in the federal science

community.

- Ideas for Implementation - ideas for a range of tools to maintain a focus on values over the long term.

The document recognizes that departments and agencies will customize any "values" and implementation strategies to their own mission and operations. It has yet to receive critical review by the 5NRs and/or the Science ADMs.

While not strictly "within government", the Public Policy Forum is both a mirror and catalyst for the evolution of the public sector. Its explicit recognition of the centrality of the interaction of science and public policy through the sponsorship of an executive exchange and a special project on the theme highlights the current interest of politicians and senior officials in doing a better job with science-based decision-making.

Two outputs from the project to date are receiving wide circulation - "The Role and Responsibilities of the Scientist in Public Policy" (Jarvis 1998) and the summary of a round table discussion of senior officials "Blood, Fish and Tears" (November 23, 1998). Both signal an emerging sensitivity to the need for good principles and practices in science advice and are ideal source materials for workshops designed to improve the mutual understanding of science and policy communities.

The fact that these initiatives are emerging spontaneously from diverse sources the importance of a collective policy capacity to underpin the development of policy for the use of science in government, as well as the lack of a clearly identified focal point at present.

3.7 Relevant Initiatives External to Government

As outlined in the companion international study, many "national academies" in other countries have either a mandate for, or have assumed a role in, providing governments with ***independent expert advice***. In many cases this role is enshrined in legislation, but not in Canada. There is not, however, consensus that there is a single body or an existing consortium of bodies in Canada that should be so identified through legislation (e.g. 1992 report from B. Segal to Industry Canada).

Despite this situation, the Royal Society of Canada (RSC) has committed to an expanded program of independent expert advice. It has published a detailed set of procedural guidelines for Independent Expert Panels (issued in 1996). This initiative has the strong support of the Society in the belief that it can and should be an important mechanism for authoritative independent advice to enhance government decision-making on complex knowledge based issues. These activities are overseen by a standing committee of the RSC .

The procedural guidelines are based on international best practice, and tailored to realistic time lines and budgets for Canada - budgets of the order of $0.25M and a 6 month time line. The essence of the

process (that can be customized to specific situations) is:

- RSC names panel members (following a review of suggested names)
- RSC approaches the best people, not necessarily RSC members; will include non-Canadians
- Expert panel reports are reviewed by external peers before being released to the government under strict rules of confidentiality
- The report is made public the same day that it is sent to the government
- Target time frame - six months

This commitment to an expanded advisory role is not yet matched with core RSC resources. The Expert Panel program is forecast to grow at a controlled rate under careful supervision to demonstrate capability and value to the point that a small infrastructure can be maintained to coordinate studies that may, in fact, be managed by external "accredited" units.

Spokespersons for the society noted the culture change that will be required for the public service to champion the importance of independent external advice for sensitive issues, reflecting that many departments rely on their own "in house" experts. An additional observation related to the difficulty in adapting the contracting out rules to the needs of independent expert reviews.

There are a number of other groups that provide independent expert advice to government. The recent reviews by the Royal College of Physicians and Surgeons and the Canadian Veterinary Medical Association for Health Canada on the two key issues relating to rBST - human health and animal health are examples of another approach. Both panels were charged with providing an objective scientific review of data, and operated with intellectual independence, but under the conflict of interest rules of Health Canada. The membership was all Canadian. The level of public debate over the role and "independence" of the panels resulted in the inclusion of the following commentary in the report of the Royal College of Physicians and Surgeons:

> *It rapidly became apparent that other issues were important to the Canadian public, to some employees of Health Canada, to members of the Senate Committee on Agriculture and Forestry and to the media. The work of the panel has been complicated by suggestions in the press and in verbal communication with members of the panel that one or more of our members, including the Chair, may have conflicts of interest. Such criticisms have persisted although the panel has proceeded on the basis that it is dealing with objective matters of science and a review of evidence on biological matters that are beyond conflict of interest. All members of the panel had previously complied with normal government standards concerning disclosure of professional activities. In the fields important to the current consideration it would be almost impossible to assemble an expert panel in Canada without including individuals who have worked with pharmaceutical companies in a scientific or consultative role. The panel wishes to underscore its role as an objective scientific review body qualified to provide advice as requested to public and private sectors.*

The use of recognized professional societies for expert advice and/or the validation of various mechanisms of providing independent advice would benefit from additional attention within the overall system of science advice. External sources of advice are under-developed, under-resources and under-utilized.

3.8 Canadian "Science in Policy" Recapitulation

The following table attempts to capture a complex and evolving set of activities designed to improve the way in which the federal government manages its science-based decision-making. They are grouped according to the key principles of the U.K. guidelines. The extent of activity is impressive, the coverage and impact patchy.

In addition, two case studies are outlined in Appendix F as illustrations of how issues are currently being handled in the science to policy process.

The U.K. guidelines have provided a powerful means of assessing the overall effectiveness and operation of the Canadian system of using science advice in decision-making. They provide a conceptual framework for the reviewer to integrate a wide range of actions and to assess strengths and gaps. However, there is a missing link - a means of ensuring their implementation. As in the U.K. the establishment of guidelines is a necessary, but not sufficient step.

Science Advice in Government Decision-Making
Examples of Government Policies, Procedures, Current Studies and Good Practices

	Initiative	Relevance to Science in Decision-Making Agenda	Comments/Examples
Identifying issues			
	Policy Research Initiative	Mechanism to develop a research strategy for Canada to prepare for the complex public policy challenges 2005 and beyond. Future oriented, horizontal issues, multi-disciplinary, inclusive.	Launched by Clerk of PCO in 1996; appears not to incorporate natural and physical sciences to any great extent. Important S&T opportunity.
	Long-term S&T strategy established within departmental mission	Solid framework for linking policy goals with long term departmental science strategy. Context for ongoing scan of emerging national and international developments.	NRCan, (e.g. the Energy Sector which has a group looking at energy futures 2030). General agreement that capacity should be strengthened.
	Science ADMs	Possible mechanism for interaction on long term foresight; however appears to be focussed more closely on internal management issues.	Very large body (about 40 attendees). Some skepticism that it could come to grips with emerging issues of substance.
	MOU among 5 NRs on S&T for sustainable development	Provides a forum for exchange of views about emerging issues among cognate departments. Sufficient common interests for cohesiveness and joint action.	Involves AAFC, EC, DFO, HC, NRCan; focus of sustainable development is long-range.
Building science into policy			

	Precautionary Principle	Constant references in SBDAs to this as an emerging issue of importance. Wide diversity in understanding of what implementation means - from inaction to taking action without scientific certainty.	Health Canada in the lead. Should be priority for more rigorous thinking and definition of concept and implications.
	S&T Management Frameworks	Guiding principles, management tools and decision-making authorities designed to increase the effectiveness and efficiency of S&T. Documents focus on the linkage between S&T and government priorities. (One document also addresses return on the S&T investment).	NRCan and Environment Canada have both developed departmental S&T management frameworks. These could be expanded to incorporate the science guidelines.
	Proposed decision-making framework - Risk Management and Science	Initiative to formalize the risk management process for rigour, consistency, accountability, transparency. Documentation to date only "overhead" decks.	Health Canada in lead. Need inter-departmental discussions to develop common language as it relates to science assessment and risk assessment/management.
	MOU among 5 departments on S&T for sustainable development (also referred to above)	Provides for collaboration via ad hoc working groups, joint science assessments, national science fora, joint science promotion and other mechanisms	MOU among AAFC, EC, DFO, HC, NRCan; seen as a cohesive and important group that is starting to make a difference.
	The Best Practices Initiative. Best Practices for the Conduct, Management and Use of Science in the Government of Canada.	Document developed through a consultative process. It outlines fundamental values, traits of key stakeholders, best practices and ideas for implementation. Addresses the organizational environment, accountabilities, the science - policy interface, the review process and communications (including limits to openness).	Health Canada led initiative among the MOU 5NR group. Document to be presented to the science ADMs. Appears more compliance oriented than facilitating.

	Existing Guidelines for External Review of internal science units	Terms of Reference for regular external unit review of quality and relevance. Effective use of external Review Agency (e.g. Canadian GeoScience Council) to manage review. Sector Advisory Board assesses the review and comments to ADM.	Earth Science Sector of NRCan has long-standing mechanism in place. Spectrum of approaches in other departments, ranging from no reviews to more ad hoc.
	Framework for External Review of R&D in Environment Canada	Draft version of operating policy and guidance on implementation of external reviews of large, significant R&D efforts within department.	Environment Canada is reviewing for possible implementation. Guidelines would underscore importance.
	Science Assessment: A report on science-policy linkages in the Atmospheric Environment Service	Report addresses the purpose and process of science assessment, use of science assessment for improved communication between science and policy and a critical evaluation of the current process through two case histories.	Environment Canada. Set of 22 recommendations to Env Can designed to facilitate science-policy interface. Generally consistent with U.K. guidelines.
	Article - The Role and Responsibilities of the Scientist in Public Policy	A discussion paper that explores various issues relating to the science - policy interface, with a particular focus on the role of the scientist.	The Public Policy Forum. New report stimulating discussion of science-policy linkages. Highlights key questions that would be partially addressed by guidelines.
	Workshop on Science-Policy Linkages	Workshop (full documentation package) designed to help scientists and policy personnel in the Canadian Forest Service (CFS) understand and manage the science-policy interface more effectively. Designed following consultation with researchers and research managers.	CFS in house initiative. Focussed and effective means of exposing scientists to the policy process and policy makers to the perspectives and concerns of scientists. Guidelines should reinforce importance of such initiatives.

	Blood, Fish and Tears: A Round Table Discussion on the Credibility and Acceptability of Science Advice for Decision-Making	Report of a Round Table, November 23, 1998. Report on the outcome of discussions among federal, provincial and a few academic leaders on policy decisions founded on or utilizing a scientific input.	Public Policy Forum. Report is witness to the importance of the science - policy interface for senior officials and ministers.
	CCMD S&T Network	Monthly meeting of S&T ADMs	CCMD-led. Useful opportunity for informal discussions
	CRUISE Conference - October 1998	Conference on "Science, Government and Global Markets: the State of Canada's Science-Based Regulatory Institutions". Dealt with many issues of managing science-based regulation on a department by department basis.	External comments on the robustness of relevant policies and practices. CSTA could consider acting as catalyst for agenda of future such meetings.
	Royal Society of Canada - Independent Expert Panels	Rigorous set of guidelines for the creation and management of an Expert Panel process. Initiative draws down on US experience, but is customized to tighter time lines and budgets.	Activity gaining respect, e.g. Primate Colony Report done for Health Canada.
Presenting policy - presumption towards openness			
	Comprehensive operational Web site	Extensive web site with text of decision documents, overview of all field trials, processes of risk assessment etc.	Canadian Food Inspection Agency (CFIA)
	Regional Resource Assessment Process	Integration of stakeholder community in peer review process of stock assessments and open dissemination of outcomes - New process.	DFO
	Multi-stakeholder processes	Many experiments ongoing with multi-stakeholder processes, e.g. the Climate Change issue tables and the Sulphur in gasoline review.	Need to have a means of evaluating and drawing out lessons from these activities to integrate into evolution of policies and practices.

	National Forum on Climate Change	"Citizen's Jury" approach to providing input on policy issue . Use of panel of Order of Canada recipients with no technical training to assess science-based policy issue.	National Round Table on the Environment and Economy. Important initiative in citizen engagement.

4 Provincial Experiences, Perceptions and Issues

An effective characterization of the use of science in government decision-making at the provincial level is well beyond the scope and time frame of this report. Practices differ dramatically among jurisdictions and among government departments within any one jurisdiction. However, the interviews and surveys provide an initial glimpse at a decision-making environment with a complex set of science-related interfaces within government and with the public and the federal government.

4.1 Objectives and Methodology

The objective in approaching provinces was to obtain insights on the extent to which science is a consideration in provincial decision-making, provincial perspectives on "good practices" and "lessons learned" in regard to the science to policy process and related communication with the public, and the interface of federal and provincial science in decision-making.

The project team carried out a series of interviews (some by telephone and some face-to-face) with senior officials in each of five provinces - Alberta, Ontario, Quebec, New Brunswick and Nova Scotia - during December 1998 and January 1999. In some instances, these interviews were supplemented by completion of a short questionnaire on existing policies, practices and barriers in the science - policy linkage. The selection of provinces for the study was influenced by need to gather primary data in a very short time. Hence, the presence of a "coordinating body" that could provide an integrated look at the use of science in government decision-making within various sectors within a province was a factor in some choices.

As in the case of the federal government, the bulk of the analysis is organized within the analytical framework provided by the U.K. science guidelines. While some examples make reference to individual provinces, certain observations are deliberately not attributed to a specific province.

4.2 Science in Provincial Governments

The science activity within science-based ministries of provincial governments runs the gamut from research (relatively infrequent and under pressure), adaptive science (not bench research, but applications and interpretation), monitoring and data collection, analysis and use. Science is targeted to missions, regulatory requirements and the socio-economic characteristics of each province. Policy is seen to drive the science, although science is seen as essential in helping to set priorities and inform good policy.

In some provinces there is relatively little science in discussions at the cabinet table; in others, there is an emerging political demand for validated scientific input to underpin decisions that has been generated by public expectations for evidence based decision-making. In some ministries there is a mature, if lean,

system of incorporating science into decision-making.

There is no simple characterization of the federal-provincial interface in regard to policy-relevant science, other than a recognition of the growing interdependence of federal science capacity and decisions and provincial interests.

4.3 Identifying Issues

> *"departments should ensure that their procedures allow the early identification of issues for which scientific advice or research will be needed"*

Provincial officials describe their capacity to identify emerging issues as "reasonable" to "weak". They work closely with stakeholder groups and see their linkage to real problems and issues as closer than that for many federal departments, but recognize that these linkages generally have a shorter-term focus. Down-sizing has reduced the provincial capacity for long-term science foresight and for being an intelligent receptor for science.

Many rely on federal science activities to provide a long-term window on emerging issues. For the majority of officials, federal provincial committees and working groups provide an important avenue for identifying emerging issues and sources of science advice. But this interface is not without its tensions. A concern was voiced that the cost sharing of research in the federal government (Agriculture and Agri-food Canada) has reduced early access to valuable research insights (interim reports used to be available to provincial officials; cost shared work is now released only in the form of a final report). There is also some skepticism of the independence of federal science from political influence, especially on environmental issues.

Linkages with universities have generally been weakened by the erosion of direct funding programs between provincial ministries and universities, reducing easy access to that source of insight. This is an unfortunate development, although in one province - Nova Scotia - provincial discussions on a "Research, Development, and Innovation (RDI) " policy have strengthened the potential for joint action and stronger international linkages. For some officials there are concerns with the lack of policy relevance of much academic research.

4.4 Building Science into Policy

> *"policy making should draw on the best available sources (including overseas), and should also take into account the views of experts in other (not necessarily scientific) disciplines"*

For most officials, government scientists are seen as a key part of the decision-making process, providing there is recognition of the limit to scientific knowledge and clarity that the role of the scientist is to ensure the accuracy of the science interpretation. There is a reduced chance of public controversy when the scientist has been part of the policy team. A contrary view was expressed by a few, that the separation of science and policy is important to delineate the need for openness in communication of science from the confidentiality of decision-making.

Generally there are few written processes for the integration of science into decision-making, instead a significant reliance on departmental/ministerial traditions and approaches. However, in one provincial ministry there is a requirement for a "science sign off" on all submissions to Cabinet and Management Board.

Capacity is an ongoing problem highlighted by many provincial officials, in both areas of traditional responsibility and in areas of emerging technologies. One of the consequences of the restructuring and cut backs is an erosion of provincial in-house science and policy capacity, a weakened connection between the two, and less ability to deal effectively with federal science activities and decisions. Particular difficulty is expected in dealing with biotechnology where science is advancing faster than public acceptance or the capacity of the government to identify and deal with issues. In the natural resources (e.g. agriculture and forestry), there is more reliance than in the past on the federal government for science input, supplemented by a more targeted activity in-house. Increasingly there are attempts to access international science and insights from the private sector.

There are two interesting ***models*** for alternative modes of providing government with science input:

- A partnership of the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) and the University of Guelph in which the university manages the former OMAFRA research and analysis function from a university base, with a performance-based contract oriented towards provincial needs. The linkage is tightened by the co-location of the ministry and the university. It is too early to assess the impact of this new marriage, but the commitment to bridge science and policy is clear.
- The Institut de recherche en santé et securité du travail headquartered in Montreal that is managed jointly by government, industry and university partners. Even under fiscal constraints it is seen as providing serious and effective input to government.

A number of provincial ministries use formally structured ***advisory committees*** or expert panels (that incorporate external experts as well as in-house personnel) as a mechanism for building science into policy and for providing a forum for multi-stakeholder debate concerning regulation and policy. The Ontario Pesticides Advisory Committee is described as a success story. It comprises representatives from ministries within government as well as external stakeholders and makes recommendations directly to the Minister.

Provincial approaches to ***risk assessment*** are diverse. In some jurisdictions it is only rarely an input to the decision-making process, in others it is a strong component. Two factors appear to influence the use of risk assessment - the political ideology about evidence based decision-making and the extent to which there is industry support for a well founded risk assessment process. There is a widespread belief that public communication on risk and risk management needs much more attention.

As in the case of the federal government, there tends to be tension between those with responsibility for the environment and those responsible for resource development (e.g. minerals and mines). This tension extends to federal-provincial fora.

4.5 Presenting Policy/Openness

> *"there should be a presumption towards openness in explaining the scientific advice and its interpretation"*

Policies on the open dissemination of science are similar to those of the federal government, with ***publication*** encouraged. There appears to be a trend in some provinces to publication in trade journals, more than the international science literature, as a better means of reaching the target audience. Time lines for publication in the international literature are a barrier to openness of communication because of the time lead involved. Like the federal government, publications are expected to focus on science and to avoid policy.

Much of the primary data and interpretations are placed on the web for the use of departmental/ministry stakeholders. In some instances these data are available only on a cost recovery basis.

Provincial governments are experimenting, not without some controversy, with new approaches to ***citizen engagement*** in the process of decision-making. Features of two such processes are noted below.

Lands for Life in Ontario

- 1997 extensive planning document placed in public domain with the objective of outlining the proposed plan for land-use management and identifying roles of stakeholders. Supporting data and analysis on the web site.
- Extensive, but time limited consultation carried out through structured process involving regional and sub-regional round tables, aboriginal peoples and citizens committees.
- Public controversy resulting from dissonance between government and stakeholder positions. The process is seen as slow and high risk by some, as too tightly constrained by unrealistic deadlines by others, but in the main constructive in terms of the quality of understanding and likely the ultimate decision.

Sydney tar ponds in Nova Scotia

- Remediation of the Sydney tar ponds has been a long-standing issue in Nova Scotia with a high degree of public concern and complex science/technology issues. It has also been a continuing area of shared federal-provincial interest and responsibility.
- Two initial approaches to tackle the problem were unsuccessful. The first involved an excavation/incineration approach that proved not to be technologically feasible. The second approach, following external advice from consultants involved encapsulation. While there was some citizen involvement in the process, it was deemed unacceptable by the population.
- The most recent approach relies on a Joint Action Group to bring in broad public participation and buy in, effectively offering ownership of the solution to the local community. The process of science and risk assessment has been public, and has involved broad public consultation. While there is still controversy over the best course of action (and who will fund the action needed), there is now improved public understanding of the nature and extent of the problem.

4.6 Federal-Provincial Issues in the Formulation and Use of Science Guidelines

While articulation of a Canadian version of the U.K. guidelines is a positive step, the constitutional division of powers between federal and provincial governments in such areas as natural resources, environment and agriculture will make their implementation more complex. Some circumstances will require active provincial participation in the process and decision-making; in other cases provincial buy-in to the decision-making process may be sufficient.

For federal science-based decisions to be accepted there must be a shared understanding at a provincial level of the nature of the issue, the integrity of the science, and the validity of its interpretation and an acceptance of the overall framework for decision-making. These conditions will prevail only when:

- There is a ***capacity*** within a provincial government for understanding and interpreting science advice whatever its source (within or external to government). An inadequate science capacity within a provincial governments is a serious handicap for federal decision-making, even in federal areas of authority. The lead-up discussions to the Kyoto agreement demonstrated large gaps in this respect.
- There is ***trust*** between federal and provincial officials working in the issue area. Such trust is cumulative, being built over time through mutual respect and productive working relationships that respect the diversity of interests and responsibilities of federal and provincial parties. Interviews demonstrated that, particularly for some environmental issues, tension rather than trust is the operational culture at the federal-provincial level.
- There is a mechanism for implementing the decision-making process in ***partnership*** where there is shared jurisdiction or provincial jurisdiction drawing on federal science. The guidelines proposed by Sir Robert May have the advantage of being at a sufficiently high level that the means of achieving the objectives can be tailored to the specific circumstances.

Provinces would not need to adopt a comparable set of guidelines for integrating science advice into decision-making at the provincial level for the above conditions to apply, but it would be an advantage. Guidelines at a provincial level would reinforce a common understanding of the means of accessing and validating science advice, as well as the role of, and limitations to, the use of that advice in a larger policy context.

Interactions with the provinces in the course of preparing this report resulted in two important comments - a) an expression of interest on the part of one province in developing a set of guidelines for its own use; and b) a suggestion that CSTA could serve a useful role in hosting (or perhaps co-hosting with provincial S&T councils) a one-day federal-provincial workshop on science guidelines, providing an opportunity to discuss international and federal practices and exchange views among provinces.

4.7 The Provinces - a Recapitulation

In their range of approaches to the incorporation of science into policy advice the provinces exhibit a diversity that parallels the alternative mechanisms and processes characteristic of individual nation states. But they are all wrestling with a series of common policy concerns. They are all dealing with an often skeptical public. They are being pressed to address issues of credibility, quality control, openness, risk and uncertainty in science and science-related issues. There are also external pressures that impact directly at a provincial level to meet standards and levels of confidence in the use of science which meet national, or even international objectives. The expectations and requirements under international conventions and new trade rules are bringing new issues to provincial cabinet tables that require more access to science in a larger policy context.

5 Discussion

5.1 Guidelines and Implementation

Many countries are exploring means of better integrating science in government decision-making. Underlying these debates are three fundamental concerns - public confidence in the science decision-making process; the tension between the opportunities opened by science and social values; and the role of science as a public good.

Addressing these concerns requires a ***series of initiatives to redefine the environment in which science is used for policy and to address the mechanisms, processes and risk communication*** involved in science based decision-making. What is needed is an assurance of sound science being brought to bear on relevant decisions, an openness in how and what science has been taken into account in policy formulation, and a meaningful engagement of citizens in shaping the decision parameters. This entails a shift towards a more open debate on those broad issues of public concern which have a strong science component and large social implications.

The development and implementation of a set of ***principles and guidelines*** for integrating science advice with policy-making is important to support and strengthen existing practices. Guidelines will facilitate consistency in practices across government and enhance public confidence in the processes of government. As in the United Kingdom, it would be appropriate for individual departments to determine how the principles and guidelines should be implemented at an operational level in a way that reflects the wide range of requirements for science advice across government.

However, the existence of such guidelines is not a panacea. First, guidelines must be viewed within the context of the continuum of the science - technology - public policy - decision-making process, reflecting both the contributions of, and limitations on, expert knowledge. Secondly, the effectiveness of guidelines depends on their active promotion and communication within the government system, as well as the explicit identification of individuals responsible for their implementation within departments and agencies. Ensuring implementation of guidelines is at least as important and more challenging than preparation of the guidelines themselves.

5.2 The Broader Context for Science Advice

Better and more explicit use of science in government decision-making and improved understanding of the role of science in government does not resolve the broad contextual issues within which the science decision-making system operates. Policy decisions are taken with explicit consideration of social, economic, environmental, legal and ethical risks and benefits. Bridging the science and policy dimensions is a process that goes beyond science.

Science is not an orderly encyclopedia of facts, but a way of looking at the world through the testing of scientific hypotheses based on accumulation and analysis of data. To integrate science into decision-making requires an expert assessment of the state of knowledge/ignorance and the scientific implications for the issue at hand. This is normally carried out through a process of ***science assessment*** in which the state of knowledge and or ignorance with respect to a specific policy issue is characterized, initially in technical language and then in language accessible to the policy maker. That process may be carried out in-house, through a multi-stakeholder process or completely external to the department. Like science, a scientific assessment is not a neat and tidy process. It draws on a mix of published literature, in house expertise and grey literature. The data utilized have uncertainties, and suffer the limitations of existing models and simulations of reality. But the end product must withstand external scrutiny, be as free from bias as possible and reveal the implications of uncertainty, all under the pressure of time. The "best professional judgement" under these circumstances requires the best professional minds.

Expert involvement in science assessment is thus crucial, but the definition of expert needs precision. Even while maintaining the highest standards in research, the interest of individuals and traditions of disciplines, as well as those of scientific publishing, can introduce undue bias into the science assessment

process unless it is carefully structured. Hence there is a need for careful design and monitoring of the process for obtaining and validating scientific knowledge.

Economic, social, cultural, ethical and legal considerations are key decision elements. The U.K. guidelines provide for a reasonable balance of inputs to ensure the full range of necessary expertise is represented in the ultimate decision-making process.

5.3 Enhanced Management Tools

The development and implementation of a set of guidelines for science advice will provide an umbrella within which a robust, government-wide body of "best practices" could be developed. There is an unfulfilled need for solid management tools to better support the initiatives of individual departments and agencies in science-based decision-making. At present, there is an ad hoc sharing of insights and experiences, but no collective knowledge base among departments and agencies of policies, principles and practices that have been effective in Canada or internationally.

Policy work is required for better understanding, and the development of useful management tools, on the relationship between the way the scientific advice is structured and its potential shortcomings/robustness. Appendix G, adapted and expanded from a recent article by David Fisk (1998), is a sampler of the type of S&T management tool that could be pursued. It explores the relationship between the way a review or assessment panel is structured and the quality/integrity of its advice.

Without some formalization in the process of interactions among departments and agencies, there will be no single point of responsibility and accountability for the development of effective management tools that could then be used by departments according to their needs. Also important is a knowledge base that will support the implementation activities of the various players.

5.4 The Environment for the Use of Science Advice

The 1996 S&T Strategy established the basic policy framework for S&T activities and funding for the federal government. The main focus of the strategy is on "policy for science" and was framed by the very real economic challenge facing Canada at the time; "science for policy" is an inherent, but not a dominant element. The 1997 report "Minding our Future" provides an update on progress towards the objectives and structures laid out in the 1996 S&T Strategy. Consistent with the theme of the original document, the update focuses primarily on the deployment of government S&T activities and funding instruments to the "wealth generation/innovation" component of the federal agenda.

In many departments, officials have a concern that the nature and importance of science for government decision-making has taken a back seat to science that is directed towards more direct support of private sector innovation and firm-level competitiveness. Without challenging the legitimacy of the "science for wealth generation" agenda, officials highlight the need for a balance of that wealth creation agenda with the mandated responsibility of governments to act in the public interest - in regard to individual health and safety and sustainability of "the commons". There is a widely held view that there is inadequate attention being given to i) the substantive policy dimensions of using science in decision-making (e.g. the changing paradigms of risk assessment and their applicability to current regulatory regimes, the implications of the precautionary principle), ii) the nature and level of in-house science

capacity, and iii) the capacity of the structures of government and its linkages with external partners to deal with complex science-based issues that touch directly on public trust.

This view is not held only within government. In a recent paper, Bruce Doern (Risky Business, 1998) suggested that Canada is dealing with a "science deficit" within the science-based regulatory regime analogous to the "financial deficit" of the 1980s and 1990s. This "science deficit" is characterized as a reduced capacity for action (in regard to science for policy) that results in an inability to cope with sustained risk.

It is not the purpose of this report to address the issue of morale within the federal S&T system, but it is clear that effective implementation of the science guidelines will benefit if both the importance and the role of science in government are better articulated. There has been a decline both in the numbers of scientists and the investment in science within government. The role of in-house science has been particularly uncertain since Program Review. Reinforcement of the fact that good science is fundamental to good policy and that the areas of policy requiring science input now extend well beyond the traditional science based departments would bring returns.

Two issues arise. First, the purpose and vitality of in-house science is undermined in the absence of a well-defined client (demand). Secondly, there is a major cultural clash between science and policy within many departments.

There are a number of means of addressing the first, among them i) direct championing of the role of science in government decision-making by the Clerk of the Privy Council Office (PCO) and ii) an extension of the existing requirements for Annual S&T Outlooks and Performance Reports to include a stronger articulation of the linkage between a department's research strategy and its policy responsibilities, and formal reports on the delivery of these responsibilities in keeping with "best practice" guidelines. These policy responsibilities often extend well beyond any one department; those cross-cutting issues could be a particular focus of attention. The effect of Canadian science guidelines should extend to the highest level of decision-making.

Among the means of addressing the second dimension are i) in-house training of existing staff to better understand the complementary role of science and policy within government and ii) recognition of the contributions to bridging science and policy in the career reward system. Means must be found to address directly the concern of scientists that the policy process is irrational and likely to distort research findings and the corresponding concern of policy advisers that scientists are inflexible and unsophisticated in their approach to policy.

5.4 Coordination Within Government

Internationally there is increasing evidence of the need to identify an honest broker in matters of S&T

with responsibilities and accountability for leadership and coordination of cross cutting issues that involve science within government. Such a responsibility is best exercised without assuming operational activities or budgetary control for science in order that it support Ministers and line managers in their individual S&T responsibilities. The position would also reinforce the need to evaluate scientific evidence within the framework of the standards of evidence used within the judicial system.

As has been described, the Science ADMs committee is important, but it is not structured to act as a nimble and flexible "honest broker" as described above. While tackling horizontal issues, it has very little policy infrastructure and is seen as being a collectivity of operational interests as opposed to the independent facilitator/broker of relationships.

This is a gap in the internal government S&T infrastructure that will be important to address for confidence that a set of science guidelines will be fully embedded in the culture and practice of the federal system of science-based decision-making.

5.5 Public Engagement and Trust

More than any other message, international experience has revealed the importance of increased openness and public engagement in the policy making process. In a recent hearing, Sir Robert May noted:

> *"...If there is one word it would be openness. It would be making sure that the process of gathering advice takes on all the difficulties of public debate, that you consult widely, that the contrary opinion be expressed, that you make such data as are available to anyone who wants them, recognizing that the result will often be a variety of opinions contending in the marketplace. This is uncomfortable...but in my view is the best single way to engender public confidence. "*
>
> R. May. June 17, 1998, Select Committee on S&T; Minutes of Evidence

Both federal and provincial governments use a range of mechanisms to obtain public input on controversial issues. These mechanisms include Royal Commissions, Independent Expert Panels, House of Commons and Senate Committees and the now disbanded Science and Economic Councils of Canada. Different mechanisms suit different political cultures and individual issues. While all are important in this array of mechanisms, there does appear to be a gap in means of providing for broader public engagement that is more pronounced today than a decade ago.

While individual departments have engaged stakeholders increasingly in the business of science-based decision making, this is not a sufficient response. The recent National Forum on Climate Change reveals

the dimensions of the gap.

The National Round Table on the Environment and the Economy brought together 25 accomplished Canadians with no predetermined views or technical expertise on the issue of climate change in a National Forum on Climate Change. The process was modelled on a "citizen's jury". The Forum was designed to engage them as a group of concerned citizens in the process of contributing to a complex area of science-based public policy through the development of a "responsible opinion" on climate change. Expert scientific opinions were presented, not infrequently divergent. The methodologies and uncertainties of science were exposed and discussed. Economic, legal, environmental, ethical and social issues were exposed and debated. After three sessions over a 3-4 month period, the panel prepared a declaration that was presented to Ministers and the Prime Minister in 1998.

In addition to the power of the process of participatory democracy and the integrative approach to a complex issue, there are some critical lessons to be learned from the exercise. Many members of the panel were skeptical of the possible political motivation for the exercise, and deeply concerned that they not be used to endorse a pre-determined policy or political position. The strict adherence to an independent and thorough process and the "honest broker" role of the National Round Table on the Environment and the Economy were effective in overcoming some aspects of this concern, but a continuing skepticism of government scientists persisted. An additional concern developed during the Forum proceedings. The panel members became irritated with the manner in which scientists presented their findings and interpretations. They found the links to public policy poorly articulated, inadequate treatment of risk, and the aggressive interactions among scientists with conflicting views unproductive.

This example illustrates the need to open up the debates on social values, ethics and science in order to provide a means to address the larger, horizontal and high profile issues that are facing government. While such processes of citizen engagement take time and resources, it is important to find means of securing greater public understanding and support for major public policy decisions that involve managing uncertainty and risk.

It is unreasonable to transplant a model directly from one culture to another, but lessons can be drawn from the experiences of other countries such as Norway and Denmark that have established structures to promote informed public debate and around controversial issues. These structures provide a means for improving public involvement in, and understanding of, policy issues on which government decisions are required. They should also shape the decision itself, through the integration of social ethics and values in the wider debate. Critical for their success is a high degree of public trust in the intellectual independence and overall strength of the agent responsible for directing and managing such an initiative.

These structures can provide an effective means of dealing with the larger horizontal issues. But even the smallest issue can become high profile if poorly managed. The extent of public concern with the science - ethics interface is demonstrated in the public press being given to "whistle-blowers" legislation

and questions of muzzling scientists. A more effective and less intrusive approach than whistle blowers legislation would be to provide a formal channel for receiving and assessing public input and concern regarding science-based decision-making on a day-to-day basis. This could function within the existing structures, principles and practices of the federal government (including access to information legislation) to respond to ongoing public views and concerns with the science - policy interface that could not be addressed in a larger thematic arena. Such moves would signal a cultural shift in addressing changing social values and emerging ethical concerns outside government.

Effective governance in a science-based society requires a series of initiatives to redefine the environment in which science is used for policy and to address the mechanisms, processes and risk communication involved in science-based decision-making.

> *"...governments that exploit opportunity will be those that have the capacity to identify risks and respond with effective long-term strategies, that engage the public in meaningful participation in decisions, and that maintain national coherence in the face of diversity. Effective governments will function as learning organizations, that is they will be creative and incorporate both new information and new concepts into their decision-making processes. Such governments will be able to operate more effectively in a world of complex systems, where forecasts are uncertain and initial conditions can lead to a multiplicity of outcomes."*
>
> Uncertainty is the Price of Freedom - paper prepared for discussion at the 1996 OECD Ministerial Symposium on the Future of Public Services"

Appendices

A Terms of Reference
B Definitions and Interpretations of Terms
C Individuals Interviewed or Who Acted as Resources in the Study
D Issues for Interview with Federal Officials
E The U.K. Science Guidelines
F Two Case Studies
G Examples of Enhanced Management Tool
H References
I Profiles of Federal Departments and Issues (separate document)

Appendix A - Terms of Reference

Scope of Study

Scientific advice is broadly defined to include advice provided by internal and external sources to those involved in recommending and making policy and regulatory decisions within the federal government, including Ministers.

The consultant will review the principles, procedures and enforcement measures documented and employed by federal government science-based departments and agencies (SBDAs) and by provincial governments regarding the use of scientific advice in government decision-making. The consultant will review if and how scientific advice guidelines are employed in cases where decisions affect and involve more than one federal department or level of government. The consultant will assess whether the principles and guidelines are adhered to and the impact of these guidelines.

The consultant will identify the consequences of an absence of, or inadequate, guidelines and where possible, review cases where scientific advice is purported to have been ignored, altered or suppressed.

Methodology

The consultant will draw on his/her past experience, the available literature and interviews with at least five key federal science-based departments and agencies and five provincial governments to report on the principles and practices employed by these organizations for the use of scientific advice in government decision-making. Key federal SBDAs should include those departments which have been the object of recent public and media concern regarding the ability of departments to effectively use scientific advice in reaching decisions.

The consultant will also review available literature, including media reports and those generated through public hearings, and interview external experts, as appropriate, to assess the effectiveness of the principles and practices employed by these organizations.

The final report will provide details on the scientific advice principles, practices and enforcement mechanisms currently utilized and identify those elements that appear to be most effective.

Deliverable

The consultant will produce a report which addresses the following:

- the role and impact of scientific advice in government decision-making;

- principles and procedures currently utilized by federal SBDAs and provinces for:

  - identifying issues for which scientific advice or research will be needed;
  - building science into government decisions (i.e. how is "the best science" accessed and built into decisions);
  - performing risk assessments;
  - communicating/presenting policy (including current departmental and government policies and procedures regarding public access to scientific findings, advice and decision making); and,
  - implementing and ensuring the use of scientific advice guidelines.

- the consequences in cases where SBDAs and provinces have not employed guidelines on the use of scientific advice in decision-making.

The consultant will provide recommendations on principles and procedures, including those relating to implementation and adherence, which appear to be successful in ensuring that government decisions take account of scientific advice.

The consultant will provide a bibliography of literature reviewed and a listing of interviews conducted.

Appendix B - Definitions and Interpretations of Terms

Science Assessment

A science assessment presents the definition of a science-related problem, reviews the state of knowledge on the relevant issues and may go further to lay out the science-related implications for government decision-making and propositions for further research.

Risks and Hazards

There is no single agreed definition of hazard and risk, but there is evidence of a number of common threads in their usage in the context of risk assessment and management:

"Hazard" - a phenomenon or circumstance perceived to be capable of causing harm or costs to society or the environment. It is associated with the *cause* of the perceived adverse condition. Three types of hazards have been explored in the literature - technological, natural and social. (adapted from Jones and Hood in "Accident and Design")

"Risk" - the probability that a substance or situation will produce harm under specified conditions. Risk is a combination of two factors:

- the probability that an adverse event will occur
- the consequences of the adverse event.

Risk encompasses impacts on human health and arises from exposure and hazard. Risk does not occur if exposure to a harmful substance or situation does not or will not occur. (From *Framework for Environmental Health Risk Management* Final Report Vol 1. 1997; The Presidential/Congressional Commission on Risk Assessment and Risk Management. USA).

Risk Assessment (US Presidential Commission)

Risk assessment is the systematic, scientific characterization of potential adverse effects of exposures to hazardous agents or activities. The four steps identified by various US bodies are hazard identification, dose-response characterization, exposure assessment and risk characterization.

NAS-NRC Model of Risk Assessment (US National Research Council. 1983. Risk Assessment in the Federal Government: Managing the Process. National Academy Press. Washington)

- Hazard identification - the determination of whether a particular chemical is or is not

causally linked to particular health effects

- Dose-response assessment - the determination of the relation between the magnitude of exposure and the probability of occurrence of the health effects in question

- Exposure assessment - the determination of the extent of human exposure before or after application of regulatory controls

- Risk characterization - the description of the nature and often the magnitude of human risk, including attendant uncertainty

Questions arising on risk assessment:

- is hazard identification sufficiently different in process and impact as to warrant a separate category and consideration?
- can questions of science be clearly separated from policy in the assessment process?

Risk Characterization (US Presidential Commission)

The process of organizing, evaluating and communicating information about the nature, strength of evidence, and likelihood of adverse health or ecological effects from particular exposure.

Risk Management (adapted from Powell, Jones and Hood...)

The process of analyzing, selecting, implementing and evaluating actions to reduce risk. It involves identifying and weighing policy instruments/alternatives in the light of the results of risk assessment. The outcome of the risk management process is the development of approaches, standards, guidelines and other recommendations for reducing and/or mitigating risk. The risk management process would normally include responsibility for defining the parameters for risk assessment.

Risk Management Framework (adapted from Shugart and the US Presidential Commission)

The US Presidential Commission identifies 6 stages in the risk management framework:

1. Define the problem and put it in context
2. Analyze the risks associated with the problem in context
3. Examine options for addressing the risks
4. Make decisions about which options to implement
5. Take actions to implement the decisions

6. Conduct an evaluation of the actions

The decision-making framework is used to manage risks. Process documentation would include:

- roles and responsibilities of all players
- identification of how the risk management process should proceed
- the decision-making criteria applicable in risk management context (health and safety, social/cultural, environmental, ethical, economic, other)
- the range of strategies and instruments (including non-intervention, communication, certification guidelines, regulation, economic incentives, direct service provision)
- means of making explicit and transparent
  - assumptions
  - uncertainties
  - differing opinions
  - how criteria were used (including competing criteria)
  - what evidence was considered (including conflicting evidence)
  - what strategies were considered and how they were assessed

The Precautionary Principle (derived from Shugart)

In regard to public health, action to reduce risk should not await scientific certainty. Essential preventative measures should not be delayed until causation has been proved with scientific certainty.

This principle is interpreted in the context of the level of risk that society regards as reasonable, and in comparison with other risks in everyday life.

There are science-related implications for government in the application of the precautionary principle, in particular there must be a capacity to identify when to act and how best to act.

Appendix C - Individuals Interviewed or Who Acted as Resources in the Study

Bruce Archibald, Ontario Energy Science and Technology
Cam Baker, Ontario Ministry of Northern Development and Mines
Doug Barnes, Ontario Ministry of the Environment
Laure Benzing-Purdie Policy, Planning & Coordination Health Protection Branch, Health Canada
Ray Bollman, Statistics Canada
Karen Brown, Environment Canada
Jim Bruce, Independent and Advisor to Environment Canada
Gary Boyd, Program Science, Fisheries and Oceans
Rita Burak, Ontario Secretary to Cabinet
Diane Campbell, Mining and Minerals, NRCan
Ken Campbell Plants, Research Branch, Agriculture and Agri-Food Canada
John Carey, Environment Canada
Steve Chadwick Information and Planning Services, Agriculture and Agri-Food Canada
Nicole Charest Research, Planning and Coordination, Agriculture and Agri-Food Canada
Bryan Cook Energy Technologies, NRCan
Dick Cowan, Ontario Ministry of Northern Development and Mines
Steven Desroches, Privy Council Office
Ron Doering, Canadian Food Inspection Agency
William Doubleday, Science Directorate, Fisheries and Ocieans
Malcolm Drury, Strategic Planning and Coordination Branch, NRCan
Jan Dyer Director Policy Branch, Agriculture and Agri-Food Canada
David Elder, Machinery of Government, Privy Council Office
Phil Enros, Science Policy, Environment Canada
Chummer Farina, ACST, Industry Canada
Bob Fessenden, Alberta Science and Research Authority
Luc Fortin, Health Protection Branch, Health Canada
Brad Fraleigh, Research Planning and Coordination, Agriculture and Agri-Food Canada
John Gammon, Ontario Ministry of Northern Development and Mines
Vinceza Galatone, Canadian Forest Service, NRCan
Fred Gault, Statistics Canada
Camil Guy, Conseil de la science et de la technologie, Quebec
Francois Lalonde, Environment Canada
Camille Limoges, Conseil de la science et de la technologie, Quebec
Richard Haedrick, Memorial University
Yvan Hardy, Canadian Forest Services, NRCan
Richard Haworth, Geological Survey of Canada, NRCan
Lorne Heslop, Science Policy and Planning, Agriculture and Agri-Food Canada
Robin Hill, Health Protection Branch, Health Canada

Norris Hoag, Ontario Agriculture, Food and Rural Affairs
Glen Holder, Ontario Ministry of Natural Resources
Paul Hough, BioTech Canada
Frank Ingratta, Ontario Agriculture, Food and Rural Affairs
Bill Jarvis, Public Policy Forum
Ken Knox, Ontario Energy Science and Technology
Dan Lane, Fisheries Resources Conservation Council and U of Ottawa
Paul LeBlond, Fisheries Resources Conservation Council
Bill Leiss, Royal Society of Canada and U of Calgary
Dalia Kudirka, Special Advisor, Biotechnology Agriculture and Agri-Food Canada
Robert MacKay, Science and Technology Secretariat, Nova Scotia
Anne MacKenzie, Science Evaluation, Canadian Food Inspection Agency
Jim MacLean, Ontario Ministry of the Environment
Fatma Maged, Strategic Planning and Coordination Branch, NRCan
Mike Maloney, Department of Agriculture, New Brunswick
Art May, Memorial University
Dan McLeod, Health Protection Branch Health Protection Branch
Mary Mes-Hartree, Canadian Forest Services, NRCan
Stéphan Mercure, Strategic Planning and Coordination Branch, NRCan
Marshall Moffat, Innovation Policy Knowledge Infrastructure Directorate, Industry Canada
Gene Nyberg, National Round Table on the Environment and the Economy
Alan Nymark, Health Canada
Donald Obonswain, Ontario Ministry of Northern Development and Mines
Chris Riddle, Ontario Energy Science and Technology
Bob Seguin, Ontario Agriculture, Food and Rural Affairs
Robert Slater, Environment Canada
Stuart Smith, National Round Table on the Economy and the Environment
Andrei Sulzenko, Industry Canada
Marie Tobin, Industry Canada
Ron Vrancart, Ministry of Natural Resources
Jean Pierre Wallot, The Royal Society of Canada
Brian Wilson, Strategic Planning and Coordination Branch, NRCan

Appendix D - Issues for Interviews with Federal Officials

1. What principles or procedures are used (and under discussion) to ensure effective integration of science into government decisions/policy advice? How are these procedures implemented, monitored and enforced? How is quality/objectivity evaluated?

2. What sources are used to obtain science input for policy advice and decision-making?

3. What practices are used to address policy issues which transcend traditional departmental mandates or federal-provincial mandates and which require science input?

4. What approaches or systems are used to identify emerging issues that may require science input?

5. What is role of, and receptor capacity for, risk assessment in science/decision-making?

6. What principles are applied with respect to public access to science advice and communication of policy and regulatory decisions?

7. What improved practices, principles or methods of enforcement (if any) are needed to address all of above issues?

Appendix E - U.K. Science Guidelines

Compendium of Guidelines - Scientific Advice in Government Policy
United Kingdom - 1997 Policy Statement by R. May, Chief Science Advisor

A Identifying Issues

1. Individual departments and agencies should ensure that their procedures can anticipate as early as possible those issues for which scientific advice or research will be needed, particularly those which are potentially sensitive. Early identification of issues should always be the aim.

2. No single approach is likely to be adequate. Instead, information should be drawn from a variety of sources and monitored by those responsible for the department or agency function as an intelligent customer for science, engineering and technology.

3. Sources may include:
   - i departments' own programmes of research. It is important that departments maintain adequate support for broadly-based longer term research to help them identify and/or respond to new and unexpected findings;
   - ii research from non-departmental sources, including international bodies (e.g. the European Commission);
   - iii departments' existing expert advisory systems, where members of committees may be specifically asked to draw attention to new areas in the scientific literature. Membership should be kept under review to ensure an appropriate range of scientific opinion is represented;
   - iv discussions with those in the Research Councils, industry, academia and elsewhere, including through the network of Foresight panels. These are likely to be most fruitful when held against the basis of long-standing relationships developed with departments;
   - v issues brought to the attention of Government by the interests directly concerned (e.g. individuals, companies, scientists or lobby groups) or by reports in the media.

4. Nonetheless, some issues will inevitably arise with little or no prior warning. Departments should ensure that they have the capacity to recognise the implications and to react quickly and efficiently to such crises.

5. It is important that there should be mechanisms for early identification of issues which affect more than one department/agency, or may have an international dimension, and for early provision and exchange of information. The Office of Science and Technology has responsibility for ensuring that SET issues which cross departmental boundaries are effectively handled. It will keep emerging transdepartmental issues under regular review, in liaison with departmental Chief

Scientists.

B Building Science into Policy

6. Once a potentially sensitive issue has been identified, departments should consider how to access the best available scientific advice. They should ensure that they draw on a sufficiently wide range of the best expert sources, both within and outside Government. They should seek wherever possible:

i to take independent advice of the highest calibre (whether provided by eminent individuals, learned societies, advisory committees, or consultants). Efforts should be made to avoid or document potential conflicts of interest, so that the impartiality of advice is not called into question;

ii to ensure that Research Councils are invited, where appropriate, to provide scientific input and contribute to interdepartmental discussions;

iii to involve experts from outside the UK, for example those from European or international advisory mechanisms, particularly in cases where other countries have experience of, or are likely to be affected by, the issue under consideration;

iv to involve at least some experts from other, not necessarily scientific, disciplines, to ensure that the evidence is subjected to a sufficiently questioning review from a wide ranging set of viewpoints;

v to ensure that data relating to the issue are made available as early as possible to the scientific community to enable a wide range of research groups to tackle the issue. Scientific advance thrives on openness and competition of ideas.

7. Where the policy issue falls within European Community competence, or is likely to affect intra-Community trade, particular attention should be paid to encouraging a sound scientific basis for Community decision-making. This may involve contributing to Community-level scientific committees, briefing the Commission on developing scientific opinion, and exchange visits by scientific experts from other Member States.

8. Drawing particularly on the principles set out in paragraph 6, departments should involve the scientists whose advice is being sought in helping them frame and assess policy options. This will help maintain the integrity of the scientific advice throughout the policy formation process.

9. In practice, deliberations frequently involve a risk assessment of one type or another. Separate

guidance on risk assessment is listed in the Annex. Recent public debate, to which the Minister for Science and Technology and the Chief Medical Officer for England have contributed, has focused in particular on the presentation and communication of risk. The Interdepartmental Liaison Group on Risk Assessment (ILGRA), chaired by HSE, provides a forum for taking forward cross-Government dialogue on these issues.

10. Departments should systematically review priorities to see whether funding needs to be directed to programmes of further research to illuminate outstanding areas of uncertainty identified. Departments' R&D programmes should conform to competitive tendering rules and be subject to robust quality assurance systems involving peer review.

11. Scientific advice will often involve an aggregation of a range of scientific opinion and judgement as distinct from statements of assured certainty. Departments should ensure that the process leading to a balanced view is transparent and consistent across different policy areas, in the light of the guidance above.

C Presenting Policy

12. In line with the Government's *Code of Practice on Access to Government Information*, there should be a presumption towards openness in explaining the interpretation of scientific advice. Departments should aim to publish all the scientific evidence and analysis underlying policy decisions on the sensitive issues covered by these guidelines and show how the analysis has been taken into account in policy formulation. Scientists should be encouraged to publish their own associated research findings.

13. Openness will stimulate greater critical discussion of the scientific basis of policy proposals and bring to bear any conflicting scientific evidence which may have been overlooked. These are good reasons for releasing information, an action which could in itself avoid greater controversy in the longer run. Departments must ensure appropriate procedures are agreed with the academic community and industry for handling intellectual property rights when information is released.

14. It is important that sufficient early thought is given to presenting the issues, uncertainties and policy options to the public so that departments are perceived as open, well prepared and consistent with one another and with the scientific advice. The difficulties associated with presenting uncertain or conflicting conclusions should not be underestimated.

15. In public presentation, departments should whenever possible consider giving scientists a leading role in explaining their advice on the science, with Ministers or policy officials describing how the Government's policies have been framed in the light of the advice received. Further

advice is available in the Government's *Code of Practice on Access to Government Information: Guidance on Interpretation*.

16. Early communication with key interest groups may be appropriate. Consideration should also be given to providing early warning of significant policy announcements to other governments and international organisations, where there are likely to be implications for other countries. Where possible, scientists from such countries or organisations should be involved in the process of consultation and advice.

D Review

17. Issues coming to Ministers for collective consideration should make clear to what extent it has been practicable to follow the advice in this note.

18. The Government's official committee on science and technology, EDS(O), will keep under review departments' and agencies' procedures for early anticipation and identification of issues for which scientific research or advice will be needed. OST will keep emerging transdepartmental issues under review. OST will also monitor implementation of the principles across departments, and include a report in the annual Forward Look of Government-funded Science, Engineering and Technology.

Appendix F - Two Case Studies

Case Study - Pulp and Paper Effluent Regulations

Situation Genesis

- 1984-85 - Swedish publication linking the level of AOX[1] as a measure of chlorinated compounds in the effluents with toxic effects. This was in turn linked to the use of the kraft process dominant in Canadian pulp and paper mills.

- Mid 1980's - significant pressure from environmental NGOs (within Canada and off-shore) on the Canadian government to introduce strict controls over AOX emissions.

- 1988 question put to researchers within Environment Canada to provide and justify a target level of AOX effluent for regulatory purposes in Canada.

Science and science advice to government

- Building on an existing strategic research program, the National Water Research Institute (NWRI) carried out strategic research that demonstrated sub-lethal physiological effects of pulp mill effluents in rivers and lakes, but did not demonstrate a link between levels of AOX and toxic responses.

- By 1991 a reasonable body of evidence was building that AOX was not a good predictor of the sub-lethal effects of pulp and paper effluents. That evidence was some 2-3 years from being sufficiently well documented (would require more data) for rigorous peer review, but there was confidence in the investigators and in the science inferences to warrant action.

- A judgement call was made that there was sufficient evidence to advise the policy makers that "we do not have the scientific evidence to make this regulation".

Process issues

- The question from the policy level was good - seeking a "number" based on good science that could be defended as an appropriate base standard for organo chlorines in pulp and paper mill effluent. It provided scope for NWRI to do a science assessment and some necessary follow-up research to provide input.

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[1] AOX = Adsorbable organic halogen.

- Anticipatory capacity - prior NRWI research had indicated analogous effects to Swedish situation, but no demonstration of link with AOX. Researchers had good awareness of international literature and controversy over issue.

- Timing - NWRI did not wait until iron-clad evidence was in. It took action to advance scientific opinion on the basis of a reasonable level of confidence (precautionary approach/principle). Had it waited, the decision-making process might have been forced into action by strong NGO pressure.

- Science - policy interface - main scientist involved had i) an understanding of the needs of the policy community and how to frame scientific advice and ii) the opportunity to present the science case to the ADM and DM.

Overall outcomes assessment[2]

- Canada - Science and science advice from NWRI influenced regulators at the federal and provincial levels in designing regulations for AOX emissions. In the case of federal regulations, AOX was not included; in some provinces, AOX limits were not as stringent as they would otherwise have been. Environment Canada's assessment is that there were no foregone environmental benefits as a result of these regulatory decisions

- International Markets - science underpinning Canadian decision changed perceptions of AOX as a toxic substance, and moderated bias against Canadian products using the kraft process.

- Economic impact - estimates:

1.	Direct savings in Canada	$1.17 billion
2.	Export market protected	$762 million

- Further research - research initially focussed on identification of "compound X" (whether or not it is chlorinated) and then moved to examine design and process changes that would minimize overall toxic effects, recognizing the complexity of interactions between the effluent and aquatic/marine environment.

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[2]Measuring the Impacts of Environment Canada's R&D. Case Study: Pulp and Paper Effluent Research. Report to Environment Canada (Marbek Resource Consultants in association with Secor Inc.), September 1997

Case Study - Regulating Sulphur in Gasoline

Situation genesis

- In 1995 the Canadian Council of Ministers of the Environment (CCME) accepted a report to develop national approaches to vehicle emission and efficiency standards and fuels formulations for Canada. One aspect of this report - sulphur in gasoline - was highly controversial with the industry and some provinces.

- Following representations from the industry, CCME asked for multi-stakeholder assessments to be undertaken to set a cost effective limit for sulphur in gasoline, taking into account associated health and environmental benefits.

Process approach

- Purposeful segregation of process into 3 phases - preparatory, fact finding and policy making (interpretation and formulation of recommendations to ministers). Final phase under control of government.

- Partnership of Environment Canada and Health Canada with provincial counterparts (both health and environment) in overseeing review.

- Stakeholder involvement - industry and NGO on Steering Committee (phase 1 and 2). The Secretariat also had an industrial nominee.

- Focus on neutrality and independence - Assessment panel process chaired ("Studies Chair") by an independent high profile person - David Johnston for credibility with the general public and private sector. Johnston also oversaw the selection of experts for the panels, panel process and Secretariat. There were negotiations with stakeholders at all stages of the process.

- Three expert panels were formed drawing in top flight expertise, including non-Canadians - Atmospheric Science; Health and Environmental Impacts; Cost and Competitiveness Assessment. The two scientific panels comprised leaders in their fields (Canada and the US) and worked autonomously, drawing on other experts as required. Much of the work on the policy side - cost and competitiveness panels - was done by consultants.

- Acceptance of outputs of expert panels - On sharing of interim reports of the expert panels, industry participants challenged the validity of the findings and attempted to discredit the review, despite active participation. Expert panel reports were not peer reviewed.

- Interpretation phase - federal-provincial working group could not reach consensus; opted for set of options and associated analysis that would go to Minister for decision. New regulations have now been gazetted.

Process issues and lessons

- Balancing stakeholder involvement - need for careful articulation of ground rules up front to ensure balance of public and private interests and to be able to provide Ministers with the necessary tools to deal with lobbying efforts.

- Structure of process - critically important are the credibility and objectivity of the panel chair, the breadth of interests and expertise on the panel, the provision of the necessary resources to underpin the expert panel work. Observation - every individual, no matter what background or affiliation, has vested interests.

- Impact of process - even with controversy, the process of an expert panel review involving stakeholders rises the substantive level of understanding of an issue among a broader community, including decision makers.

- Dealing with uncertainty in a policy context - there is a natural tendency of expert panels and stakeholders to seek an iron clad level of proof in relation to the scientific inferences. Government involvement in the process was seen to enhance the likelihood of a policy relevant outcome focussed on "best professional judgement given the state of knowledge and uncertainty today".

Appendix G - Example of Enhanced Management Tool
Overview of Issues in the Constitution of an Advisory or Review Panel[3]

Potential Bias or Pitfall	*Problem Caused*	*Means of Mitigating Problem*
Single expert bias	Use of one expert; tendency to overestimate extent of agreement with own view	Peer review of science assessment
Disciplinary paradigm bias	Working assumptions set in cognitive framework of a single discipline. Can produce limiting set of interpretations and a lack of a systems approach	Careful definition of the question that is being addressed by the science assessment Multi-disciplinary panel
Erroneous logic	Assumption that absence of error to support a proposition is equivalent to the presence of evidence that refutes it.	Careful training of scientists in the presentation of implications.
Non-systems bias	Analytical methodology of science assessment does not address integrated resource management	Careful definition of the question that science is informing Science assessment in context of integrated resource management
Undue certainty	Inadequate attention to uncertainty, probabilities and risk	Develop protocols for presenting uncertainty and probabilities (e.g. small scale probabilistic models)
Exclusionary bias	Data from non-traditional and un-peer reviewed sources excluded, regardless of potential relevance and contribution to conceptual framework (e.g. fisheries)	Incorporate knowledgeable users in science assessment process. Provide means of integrating and reviewing data from non-traditional knowledge sources . Also provide means of voicing divergent views
Unbalanced data sample	Data in the public domain not representative of actual knowledge base (publishing habits of industry and/or journals). Tends to exaggerate uncertainty of knowledge	Release interim findings of science assessment for wider public comment than simply peer review

[3]Derived from Fisk (1998).

Imagination block	Lack of imagination regarding the significance and implications of available data. Tendency to limit full range of interpretations	Wide circulation of interim findings to groups that would not participate in the science assessment from concerns of being compromised
Gender or ethnic bias	Limitations on the source of data or nature of interpretations considered	Ensure that expert panel draws on an appropriate diversity of members and sources of input
Future funding implications	Conjectures support research funding decisions favorable to participants interests. Tendency to focus on hypotheses that require more research	Separate science assessment from the assessment of a future research agenda. Include in the process individuals who would not benefit from funding

Appendix H - References[4]

Papers Presented at the CRUISE Conference on Science, Government and Global Markets

1. *A Modest Means for Major Ends: Creating the Canadian Food Inspection Agency and Modernizing Science-Based Regulation*. Michael J. Prince (U Victoria) 1998 CRUISE Conference.

2. *Science-Based Regulation and International Harmonization and Coordination in Global Markets*. Douglas Powell (U Guelph) 1998.CRUISE Conference.

3. *Between Expertise and Bureaucracy: Risk Management Trapped at the Science/Policy Interface*. William Leiss (Queen's University). 1998 CRUISE Conference.

4. *Bovine Spongiform Encephalopathy (Mad Cow Disease): the lessons for public policy*. Eric Millstone and Patrick van Zwanenberg (Sussex University). 1998 CRUISE Conference.

5. *Risky Business: Canada's Changing Science-Based Regulatory Regime*. G Bruce Doern (Carleton). 1998. CRUISE Conference.

6. *The Therapeutic Products Programme of Health Canada: From Traditional Science-Based Regulation to Science-Based Risk-Benefit Manager?*. G Bruce Doern (Carleton). 1998. CRUISE Conference.

8. *Fisheries and Oceans Canada: Science and Conservation*. Daniel E. Lane (U. Ottawa) 1998.CRUISE Conference.

9. *"Patient Science" versus "Science on Demand": The stretching of Green Science at Environment Canada*. G. Bruce Doern (Carleton). 1998. CRUISE Conference.

10. *A Question of Balance: New Approaches for Science Based Regulations*. Bill Jarvis (Public Policy Forum) 1998. CRUISE Conference.

12 *Science, Regulation and Globalization: Highlights from a Recent Conference on Canada's Science-Based Regulatory Institutions*. A Report to the CCMD ADM Network on Regulation and Compliance. Margaret M. Hill-Campbell. November 17, 1998.

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[4]Note - See departmental profiles for additional key references. These are not reproduced in this list. Also, see references cited in the International Report.

Generic Canadian Studies on Science Decision Making in Government

1. *The Peripheral Nature of Scientific and Technical Controversy in Federal Policy Formation*. G. Bruce Doern. Science Council of Canada Background Study 46. 19981.

2. *Public Inquiries in Canada*. Liora Salter and Debra Slaco. Science Council of Canada. Background Study 47. 1981.

3. *Regulating the Regulators: Science, Values and Decisions*. Science Council of Canada Report. 1982.

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